EXHIBIT B

BLACK&DECKER

Correlation Report

Correlation Report between Black & Decker Ultrasonic Pest Repellers and Weitech Ultrasonic Pest Repellers

Applica™

Applica Consumer Products, Inc.

Correlation report between Black and Decker Ultrasonic Pest Repellers and Weitech Ultrasonic Pest Repellers

Final Report

Submitted by

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January 23, 2004

Objective: Perform tests using the Black & Decker EX/EP/EW models of ultrasonic pest repellers. Publish a report to include a table that correlates the performance of the Black & Decker models with those previously tested and documented Weitech models. The report shall have efficacy data of the ultrasound technology on various pests such as cockroaches, spiders, and mice. A table shall be presented with the following fields: Black & Decker model #, species tested, frequencies emitted by the unit, voltage magnitude as compared to the Weitech models. The Black & Decker models are as follows: EP310, EP320, EX410, EX420, EW411, EW421, EP610, EP620, EX710, EX720, EX900-A, EP920-A, EX920-A, EX1100-A, EP1100-A, VX216, VX226.

Discussion: Applica Consumer Products, Inc acquired the Weitech Company and their line of ultrasonic pest repellers in the year 2002. Today, Applica continues to manufacture ultrasonic pest repellers under the branded name of Weitech, Pest-X, Vermin-X, and now Black and Decker. All internal components, such as capacitors, resistors, light emitting diodes, printed circuit board, and ultrasonic acoustical speakers; have remained the same in order to continue to provide the variable ultrasonic sound technology for pest repellant as originated at the Weitech Company.

Efficacy Report #	Device Model	Pest Species	Working frequency output
WEI-98260	Weitech 500B	Wild House Mice	26 – 45

The following ultrasonic pest repellers were tested for working frequency output and correlated with the efficacy report WEI-98260 for repelling wild house mice.

Correlation Table

Brand	Model	Frequency Peak kHz	Voltage Magnitude	Wild House Mice
Weitech	0540	26 – 45	5 – 7	X
B&D	EP310	27 – 43	5 – 7	X
B&D	EP320	27 – 46	5 – 7	X
B&D	EX410	26 – 45	5 – 7	X
B&D	EX420	27 - 48	5 – 7	X
B&D	EW411	26 – 45	5 – 7	X
B&D	EW421	27 - 48	5 – 7	X
Vermin-X	VX216	26 - 45	5 - 7	X
Vermin-X	VX226	26 - 45	5 - 7	X
Weitech	0185	26 – 45	4 – 7	X
B &D	EP610	26 – 44	4 – 7	X
B&D	EP620	27 – 46	4 – 7	X
B&D	EX710	26 – 48	4 – 7	X
B&D	EX720	26 - 47	4 – 7	X
Weitech	0220	A: 9 – 50 B: 9 – 50	A: 23 – 63 B: 10 – 35	X
B&D	EX900-A	A: 10 – 50 B: 9 – 52	A: 23 – 63 B: 10 – 35	X

B&D	EP920-A	A: 9 – 51 B: 9 – 52	A: 23 – 63 B: 10 – 35	X
B&D	EX920-A	A: 10 – 53 B: 10 – 49	A: 23 – 63 B: 10 – 35	X
Weitech	0600	5 – 85	19 – 37	X
B&D	EP1100-A	5 – 81	20 - 36	X
B&D	EX1100-A	5 – 81	20 – 36	X

Efficacy Report #	Device Model	Pest Species	Working frequency output
WEI-98009	Weitech CIX0600	Wild Norway Rats	25 – 40

The following ultrasonic pest repellers were tested for working frequency output and correlated with the efficacy report WEI-98009 for repelling wild Norway rats.

Correlation Table

Brand	Model	Frequency Peak kHz	Voltage Magnitude	Wild Norway Rats
Weitech	0540	26 – 45	5 – 7	X
B&D	EP310	27 – 43	5 – 7	X
B&D	EP320	27 – 46	5 – 7	X
B&D	EX410	26 – 45	5 – 7	X
B&D	EX420	27 - 48	5 – 7	X
B&D	EW411	26 – 45	5 – 7	X
B&D	EW421	27 - 48	5 – 7	X
Vermin-X	VX216	26 - 45	5 - 7	X
Vermin-X	VX226	26 - 45	5 - 7	X
Weitech	0185	26 – 45	4 – 7	X
B &D	EP610	26 – 44	4 – 7	X
B&D	EP620	27 – 46	4 – 7	X
B&D	EX710	26 – 48	4 – 7	X
B&D	EX720	26 - 47	4 – 7	X
Weitech	0220	A: 9 – 50 B: 9 – 50	A: 23 – 63 B: 10 – 35	X
B&D	EX900-A	A: 10 – 50 B: 9 – 52	A: 23 – 63 B: 10 – 35	X
B&D	EP920-A	A: 9 – 51 B: 9 – 52	A: 23 – 63 B: 10 – 35	X
B&D	EX920-A	A: 10 – 53 B: 10 – 49	A: 23 – 63 B: 10 – 35	X
Weitech	0600	5 – 85	19 – 37	X
B&D	EP1100-A	5 – 81	20 - 36	X
B&D	EX1100-A	5 – 81	20 – 36	X

Efficacy Report #	Device Model	Pest Species	Working frequency output
Huang 6-02	Weitech CIX0600	German Cockroaches	26 – 45

The following ultrasonic pest repellers were tested for working frequency output and correlated with the efficacy report Huang 6-02 for repelling German Cockroaches.

Correlation Table

Brand	Model	Frequency Peak kHz	Voltage Magnitude	German Cockroaches
Weitech	0540	26 – 45	5 – 7	X
B&D	EP310	27 – 43	5 – 7	X
B&D	EP320	27 – 46	5 – 7	X
B&D	EX410	26 – 45	5 – 7	X
B&D	EX420	27 - 48	5 – 7	X
B&D	EW411	26 – 45	5 – 7	X
B&D	EW421	27 - 48	5 – 7	X
Vermin-X	VX216	26 - 45	5 - 7	X
Vermin-X	VX226	26 - 45	5 - 7	X
Weitech	0185	26 – 45	4 – 7	X
B &D	EP610	26 – 44	4 – 7	X
B&D	EP620	27 – 46	4 – 7	X
B&D	EX710	26 – 48	4 – 7	X
B&D	EX720	26 - 47	4 – 7	X
Weitech	0220	A: 9 – 50 B: 9 – 50	A: 23 – 63 B: 10 – 35	X
B&D	EX900-A	A: 10 – 50 B: 9 – 52	A: 23 – 63 B: 10 – 35	X
B&D	EP920-A	A: 9 – 51 B: 9 – 52	A: 23 – 63 B: 10 – 35	X
B&D	EX920-A	A: 10 – 53 B: 10 – 49	A: 23 – 63 B: 10 – 35	X
Weitech	0600	5 – 85	19 – 37	X
B&D	EP1100-A	5 – 81	20 - 36	X
B&D	EX1100-A	5 – 81	20 – 36	X

Efficacy Report #	Device Model	Pest Species	Working frequency output
Huang 6-02	Weitech Transonic800	Greenhouse Spider	27 – 42

The following ultrasonic pest repellers were tested for working frequency output and correlated with the efficacy report Huang 6-02 for repelling German Cockroaches.

Correlation Table

Brand	Model	Frequency Peak kHz	Voltage Magnitude	Greenhouse Spider
Weitech	0540	26 – 45	5 – 7	X
B&D	EP310	27 – 43	5 – 7	X
B&D	EP320	27 – 46	5 – 7	X
B&D	EX410	26 – 45	5 – 7	X
B&D	EX420	27 - 48	5 – 7	X
B&D	EW411	26 – 45	5 – 7	X
B&D	EW421	27 - 48	5 – 7	X
Vermin-X	VX216	26 - 45	5 - 7	X
Vermin-X	VX226	26 - 45	5 - 7	X
Weitech	0185	26 – 45	4 – 7	X
B &D	EP610	26 – 44	4 – 7	X
B&D	EP620	27 – 46	4 – 7	X
B&D	EX710	26 – 48	4 – 7	X
B&D	EX720	26 - 47	4 – 7	X
Weitech	0220	A: 9 – 50 B: 9 – 50	A: 23 – 63 B: 10 – 35	X
B&D	EX900-A	A: 10.– 50 B: 9 – 52	A: 23 – 63 B: 10 – 35	X
B&D	EP920-A	A: 9 – 51 B: 9 – 52	A: 23 – 63 B: 10 – 35	X
B&D	EX920-A	A: 10 – 53 B: 10 – 49	A: 23 – 63 B: 10 – 35	X
Weitech	0600	5 – 85	19 – 37	X
B&D	EP1100-A	5 – 81	20 - 36	X
B&D	EX1100-A	5 – 81	20 – 36	X

Efficacy Report #	Device Model	Pest Species	Working frequency output
Huang 6-02	Weitech Transonic100	Long Bodied Cellar Spider	27 – 35

The following ultrasonic pest repellers were tested for working frequency output and correlated with the efficacy report Huang 6-02 for repelling Long Bodied Cellar Spider.

Correlation Table

Brand	Model	Frequency Peak kHz	Voltage Magnitude	Long Bodied Cellar Spider
Weitech	0540	26 – 45	5 – 7	X
B&D	EP310	27 – 43	5 – 7	X
B&D	EP320	27 – 46	5 – 7	X

B&D	EX410	26 – 45	5 – 7	X
B&D	EX420	27 - 48	5 – 7	X
B&D	EW411	26 – 45	5 – 7	X
B&D	EW421	27 - 48	5 – 7	X
Vermin-X	VX216	26 - 45	5 - 7	X
Vermin-X	VX226	26 - 45	5 - 7	X
Weitech	0185	26 – 45	4 – 7	X
B &D	EP610	26 – 44	4 – 7	X
B&D	EP620	27 – 46	4 – 7	X
B&D	EX710	26 – 48	4 – 7	X
B&D	EX720	26 - 47	4 – 7	X
Weitech	0220	A: 9 – 50 B: 9 – 50	A: 23 – 63 B: 10 – 35	X
B&D	EX900-A	A: 10 – 50 B: 9 – 52	A: 23 – 63 B: 10 – 35	X
B&D	EP920-A	A: 9 – 51 B: 9 – 52	A: 23 – 63 B: 10 – 35	X
B&D	EX920-A	A: 10 – 53 B: 10 – 49	A: 23 – 63 B: 10 – 35	X
Weitech	0600	5 – 85	19 – 37	X
B&D	EP1100-A	5 – 81	20 - 36	X
B&D	EX1100-A	5 – 81	20 – 36	X

Results: All Black and Decker Ultrasonic Pest Repellers in this correlation study closely correlated in performance, frequency, and voltage magnitude; when compared to previously tested Weitech models used in studies repelling mice, cockroaches, and spiders.

BLACK&DECKER

Wild House Mice

Laboratory Evaluation of
Ultrasonic Devices:
Weitech Model 500 B Electronic
Pest Repeller

Applica™
Applica Consumer Products, Inc.

Laboratory Evaluation of Ultrasonic Devices:
Weitech Model 500B Electronic Pest Repeller on wild House mice (*Mus musculus*)

BioCenotics Project # WEI-98260

Issue date: December 30, 1998

Prepared for: Weitech, Inc.

Author: A. Daniel Ashton

Laboratory Evaluation of Ultrasonic Devices
Project #: WEI-98260

Objective

Testing evaluated the performance of the Weitech Transonic Model 500B (Pace speaker) Electronic Pest Repeller on wild house mice (*Mus musculus*).

Methodology

Species:	wild house mice (*Mus musculus*)
Number/sex:	six mice per test (two replicates of 3 mice per replicate)
Length of test:	12 days per replicate
Device on:	Days 3 through 10

Candidate test animals were held under laboratory conditions for at least seven days of observation prior to test initiation. Animal hearing was checked prior to testing by observation for Preyer's Reflex--a reaction to a loud noise. Test animals were individually housed in an apparatus. Three apparatuses were used for each replication; two replications comprised the test. Each apparatus consisted of four chambers (treated, untreated, nest, and connecting), configured in a T-formation.

The treated and untreated chambers each contained a single food bowl. The nest chamber contained a wooden nest box and cotton nesting material. Food and water were provided *ad libitum* throughout the study.

Output of all components of the ultrasonic system was performed (Phase 1). The Weitech Model 500B Electronic Pest Repeller was then installed in the test apparatus and sound levels measured at specific sites inside the apparatus (Phase 2).

A mouse was placed in a test apparatus with food provided in the treated and untreated chambers—one containing the ultrasonic test device and the other containing no test device—for 12 days (Phase 3). The ultrasonic device was activated at 48 hours post placement and deactivated after the tenth day (Day 8 of treatment) and the mouse was removed after Day 12. See attached Protocol for further details.

Results

Phase 1—Device Measurements

Sound patterns (frequency and amplitude) were consistent for each of four Weitech Model 500B (Pace) Electronic Pest Repeller units. The primary source of the total sound output was in ultrasonic frequencies at 40 kHz and above. Sound output dropped only slightly at 31.5 kHz while sound output at frequencies of 20 kHz and below was negligible. Readings for the three units at all available settings are presented in Tables 1 and 2.

Phase 2—Apparatus Measurements

Units were installed in three separate apparatuses. The amplitude in the treated chamber was >94 dB in each apparatus, while the difference between the treated and untreated chambers was ca. 34 dB. Sound from the ultrasonic unit was generally to the treated chamber, the passageway between the sound and connecting chambers and the opening to that passageway. Sound amplitude in the nest and untreated chambers was equivalent to background noise level.

Phase 3—Animal Observations

Food consumption in the treated chambers represented approximately 59.3% of the total food consumed during pre-treatment (Table 4). Food consumption in the treated chambers declined to only 26.8% of the total food consumed during the treatment period. Correspondingly, food consumption was reduced 48.3% in the treated chambers, while consumption in untreated chambers increased 106.2%. Clearly the mice chose to avoid the ultrasonic sound. The ratio of food consumption in the treated versus untreated chambers trended toward pretreatment levels during post treatment.

A slight decrease in rodent tracking board activity also was noted on Day 1 of treatment (Table 5). The trend was consistent throughout the eight days of treatment Changes in tracking board activity and food consumption were similar throughout all phases of the test. Tracks in treated chambers accounted for 49.1% of totals during pre-treatment. This proportion was reduced to 43.9% during the treatment phase, while average tracking board activity decreased 26.8% in the treated chambers during the treatment phase. Post-treatment tracking board activity remained subdued during the limited post treatment period. No mice exhibited any apparent hearing loss during the test.

Food consumption and tracking board activity measures both demonstrated repellency, however, neither food consumption nor tracking boards were reduced >60%, the an EPA-suggested performance standard for laboratory evaluation of ultrasonic devices. The devices utilized during the test had an output average of 94 dB at 1 meter (linear, Table 2). The units also produced approximately 94 dB in the chambers (at mouse level). The sound was apparently annoying to some of the mice as they chewed on the extension cords used to hang the test units. Overall activity declined during the treatment period in both treated and untreated chambers, when compared to pretreatment activity.

The tested units appear to be operating at the margin of acceptance. The units also are operating at effective frequencies slightly above 40 kHz. It is interesting to note that overall activity remained subdued during the post treatment phase. It is possible that mice, conditioned to feed in the untreated areas, are slow to revert to old feeding areas. Consequently, there may be a residual effects related to sound intensity and duration.

Tables

Table 1. Sound pressure measurements (dB at 1/2 meter) of three Weitech Model 500B Electronic Pest Repeller (no serial numbers) at selected frequencies (kHz), background range in parentheses.

Unit No.	Linear (66)	40 kHz (37)	31.5 kHz (37)	25 kHz (36)	20 kHz (36)	16 kHz (36)	12.5 kHz (35)	10 kHz (35)	8 kHz (35)
1	101	100	92	90	65	51	42	39	37
2	100	100	91	87	61	47	41	38	37
3	103	103	92	92	65	51	43	40	38

Table 2. Sound pressure measurements (dB at 1 meter) of three Weitech Model 500B Electronic Pest Repeller (no serial numbers) at selected frequencies (kHz), background range in parentheses.

Unit No.	Linear (66)	40 kHz (37)	31.5 kHz (37)	25 kHz (36)	20 kHz (36)	16 kHz (36)	12.5 kHz (35)	10 kHz (35)	8 kHz (35)
1	93	93	84	76	52	40	37	36	35
2	94	94	85	76	51	41	37	36	36
3	96	96	83	74	50	41	38	36	36

Table 4. Daily food consumption (grams) by wild house mice(*Mus musculus*) in chambers of test apparatuses.

		Body weight (g)		Pre-treatment				Treatment							
				DAY 1		DAY 2		DAY 1		DAY 2		DAY 3		DAY 4	
Animal	Sex	Initial	Final	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated
1	M	24.1	24.2	1.2	1.8	1.3	1.6	1.8	1.0	2.8	1.0	0.7	2.3	2.1	1.2
2	M	17.6	16.0	1.8	2.1	0.9	1.0	2.3	0.0	1.9	0.3	2.2	0.4	1.8	0.3
3	M	17.2	17.0	0.0	0.4	0.3	1.3	1.1	1.1	1.1	0.9	1.9	0.8	1.6	0.5
1	F	16.4	16.0	0.9	1.0	0.5	1.2	1.5	0.1	1.7	0.2	1.9	0.0	2.1	0.1
2	F	15.9	14.9	0.9	0.6	0.6	1.1	1.3	0.6	1.1	0.6	1.4	0.5	1.5	0.2
3	F	14.1	15.6	0.5	1.4	0.8	0.6	1.3	0.7	1.4	0.3	1.7	0.6	1.8	0.2
Mean		17.55	17.28	0.88	1.22	0.73	1.13	1.55	0.58	1.67	0.55	1.63	0.77	1.82	0.42

		Treatment								Post Treatment			
		Day 5		Day 6		Day 7		DAY 8		DAY 1		DAY 2	
Animal	Sex	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated
1	M	2.2	1.1	2.0	1.5	1.9	1.6	1.8	1.3	1.1	2.4	0.9	2.2
2	M	1.0	0.6	1.9	0.5	1.8	0.6	0.8	1.2	0.7	1.6	1.0	1.5
3	M	1.8	1.1	2.5	0.2	1.2	1.6	1.3	1.5	1.5	1.5	1.1	1.6
1	F	1.4	0.0	1.9	0.0	1.7	0.1	1.9	0.0	1.5	0.5	1.8	0.3
2	F	1.4	0.3	1.7	0.2	0.8	0.8	1.2	0.7	1.2	1.2	1.1	0.7
3	F	2.1	0.1	1.7	0.2	2.1	0.1	1.8	0.0	1.8	0.1	2.2	0.0
Mean		1.65	0.53	1.95	0.43	1.58	0.8	1.47	0.78	1.3	1.22	1.35	1.05

Table 5. Mean daily activity index of wild House Mice (Mus musculus) in test apparatus.

	Pre-treatment				Treatment							
	Day 1		Day 2		Day 1		Day 2		Day 3		Day 4	
Animal No.	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated
1M	77	72	44	45	42	36	40	28	46	30	40	38
2M	122	107	80	85	90	72	100	76	86	60	67	67
3M	104	90	80	85	80	80	76	76	76	76	80	67
1F	115	104	90	95	90	90	94	76	94	59	80	67
2F	90	76	67	56	67	74	68	64	60	56	39	46
3F	72	86	76	80	72	52	64	74	41	64	67	52
Mean of means	97	89	73	74	74	67	74	66	67	58	62	56

	Treatment								Post Treatment			
	Day 5		Day 6		Day 7		Day 8		Day 1		Day 2	
Animal No.	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated
1M	47	31	56	41	69	59	56	48	51	72	64	46
2M	68	61	85	67	80	63	80	60	80	85	90	80
3M	85	80	94	76	168	76	110	80	90	80	85	85
1F	67	40	67	63	67	60	85	61	65	85	65	82
2F	53	56	52	56	48	49	45	50	42	42	52	46
3F	56	39	56	40	67	63	56	64	80	68	56	64
Mean of means	63	51	68	57	83	62	72	61	68	72	69	67

[a] see Appendix A for description of index.

Protocol

PROTOCOL

TITLE: LABORATORY EVALUATION OF ULTRASONIC DEVICES

Project #: WEI-98260

1. Objective: Testing will evaluate the effect of the Weitech Model 500 (2nd Edition) plug-in repeller on wild house mice (*Mus musculus*).

2. Sponsor: Weitech, Inc.
   251 West Barclay Drive
   P. O. Box 1659
   Sisters, OR 97759
   phone: 541.549.0205
   fax: 541.549.8154

3. Test Facility: BioCenotics, Inc.
   4880 Hudson Road
   P. O. Box 117
   Osseo, MI 49266-0117
   phone: 517-523-3441
   fax: 517-523-3052

4. Proposed Start Date: September 10, 1998
   Proposed Completion Date: October 9, 1998

5. Authorization:

   Stewart Weitzman — 10/1/98
   Stewart Weitzman, Date
   President
   Weitech, Inc.

   A. Daniel Ashton — 9/10/98
   A. Daniel Ashton, Date
   Study Director
   BioCenotics, Inc.

6. Test Devices:

   A. Device/System Tested: Name:/Model #: Weitech Model 500 (2nd Edition) plug-in pest repeller.

   B. Sound Measurement Equipment: Bruel Kjaer brand.

These readings are used to confirm:

1. Ultrasonic sound is limited to the sound chamber and sound-side passageway.
2. The amplitude (sound intensity, dB) in the sound chamber must be equal to or greater than the specifications listed in the manufacturers product literature.
3. Amplitude differential between sound and quiet chambers shouled be at least 15 dB.

Phase 3 (Animal observations): Three individually housed animals comprise one replication; two replicates comprise a test. Each replication will run for 12 days: two days of pretreatment observation; eight days of treatment observation (ultrasonic device on); and two days of post-treatment observation.

Pretreatment: Animals are weighed and placed in the nest box chamber of the test apparatus. Food is provided and consumption is recorded daily. A tracking board will be placed under the portal of the passageway to both the sound and quiet chambers, as well as along the sides of these chambers. Rodent tracks will be counted and boards replaced daily. Observations of mouse behavior within the apparatus also are recorded as appropriate. The pretrement phase will last for two (2) days.

Treatment: The ultrasonic system is turned on after 48 hours and daily food consumption, tracking data, and mouse behavior observations is recorded for four days.

Post-treatment: The ultrasonic system is turned off and daily data collection and observations are continued for two additional days. Animals are removed, weighed, evaluated for fitness, and tested for Preyer's Reflex. The latter is used to determine if any damage to animal hearing occurred during the study.

9. Challenge Diet: EPA (65% ground corn, 25% ground steam rolled oats, 5% corn oil, and 5% powdered sugar).

10. Control Group: This test format allows for use of pretest and post-test data as an internal control for test group animals. Data collected when the ultrasonic system is on is compared with data collected when this system is off. Use of this form of control mitigates against variation in test results due to animal behavior variability.

11. Other Considerations:

A. Any special safety, handling, use, or installation procedures identified in the manufacturer's product literature will be followed during this study.

B. Efficacy Criteria: No efficacy criteria are required for this test. However, the EPA suggests performance standards under laboratory and field conditions for devices should produce repellencies of 60% or greater.

C. Disposition of Animals: Animal health status will be evaluated at conclusion of the study, and healthy animals will be labeled and retained for future testing, while any unhealthy animals will be euthanized by cervical dislocation.

12. Statistical Methodology: None.

Results will be reported in tables and/or graphs of test unit efficacy as demonstrated by:

1. sound reading results for the Model 500 plug-n repeller units
2. sound reading results for the installed Model 500 plug-n repeller units in the test apparatus
3. daily animal food consumption data results
4. daily animal tracking census data results
5. daily mouse behavior observation results

13. Data Storage: All raw data and copies of the final report are stored at BioCenotics, Inc., Osseo, MI.

14. References:

A. Canadian Ultrasonic Device Protocol (1984).
B. EPA (1993). Ultrasonic device protocol guidelines.
C. EPA Good Laboratory Practice Standards (40 CFR, Part 160).
D. Guide for the Care and Use of Laboratory Animals (1996), National Research Council, National Academy Press, Washington, D. C.
E. IEC free field sound measurement standard.
F. OSHA human sound exposure guidelines for continuous/intermittent sound under 20kHz.

15. Amendments: NA.

APPENDIX A

Daily tracking board observation index

The following index was used to report tracking board observations. Tracks were counted or estimated and the mean for the appropriate class was used for data analysis.

Tracks counted	Mean
0	0
1-5	3
6-10	8
11-19	15
20-28	24
29-41	35
42-54	48
56-71	63
72-88	80
89-109	99
110-130	120
131-155	143
156-180	168
181-209	195
210-238	224
>239	255

CO/PROJECT #: WEI-98260
GROUP ID: 11
TEST MATERIAL: Waterbed 500 (Pose)

BIOCENOTICS DATA FORM A.7

% ACTIVE: NA
PLACEBO: NA

DATA SHEET 1 OF 2
SPECIES: [illegible]
TEST PERIOD: 10-14-98 / 10-26-98

QC = Purina 5001 Meal
DOD = Day of Death

DAILY CONSUMPTION (G) — Pre-26: -1, 0; Test-8D: 1, 2, 3, 4, 5

Animal #/Sex/Wt		Bowl #/Material/Wt		-1 Q	-1 S	0 Q	0 S	1 Q	1 S	2 Q	2 S	3 Q	3 S	4 Q	4 S	5 Q	5 S	DOD	Comments
1M	i 24.1	1 EPA	i	337.3	337.0	336.1	335.2	334.8	333.6	333.8	332.6	331.0	331.6	330.3	329.3	328.2	328.1		
	f 24.2		f	336.1	335.2	334.8	333.6	333.0	332.6	331.0	331.6	330.3	329.3	328.2	328.1	326.0	327.0		
			d	1.2	1.8	1.3	1.6	1.8	1.0	2.8	1.0	0.7	2.3	2.1	1.2	2.2	1.1		
2	i	2 TB	i	12	19	16	17	17	11	3	3	6	8	7	4	6	11		Unit # 5
	f		f	90	95	50	70	62	47	61	55	60	42	52	40	53	40		
			d	55	56	13	46	29	11	0	12	32	31	18	55	32	20		
3	i	3 TB	i	95	75	48	31	37	51	51	35	55	33	60	54	80	60		
	f		f	55	55	60	38	41	32	42	0	22	4	38	6	20	4		
			d																
2#M	i 17.6	4 EPA	i	342.8	337.9	341.0	335.8	340.1	334.8	337.8	334.8	335.9	334.5	333.7	334.1	331.9	333.8		
	f 16.0		f	341.0	335.8	340.1	334.8	337.8	334.8	335.9	334.5	333.7	334.1	331.9	333.8	330.0	333.2		S and wood chewed D4
			d	1.8	2.1	0.9	1.0	2.3	0.0	1.9	0.3	2.2	0.4	1.8	0.3	1.9	0.6		
5	i	5 TB	i	24	16	14	17	12	12	12	19	7	10	6	18	7	20		Unit # 6
	f		f	160	160	95	90	125	90	105	90	110	57	75	80	90	85		power cord
			d	100	90	75	85	85	70	75	65	80	40	65	60	60	33		connectors exposed
6	i	6 TB	i	110	95	75	85	80	58	140	60	80	80	65	55	60	50		
	f		f	90	70	70	75	75	65	85	75	70	60	70	65	51	75		
			d																
3#M	i 17.2	7 EPA	i	336.5	340.1	336.5	339.7	336.2	338.4	335.1	337.3	334.0	336.4	332.1	335.6	330.5	335.1		
	f 17.0		f	336.5	339.7	336.2	338.4	335.1	337.3	334.0	336.4	332.1	335.6	330.5	335.1	328.7	334.0		S and wood chewed D2
			d	0.0	0.4	0.3	1.3	1.1	1.1	1.1	0.9	1.9	0.8	1.6	0.5	1.8	1.1		
8	i	8 TB	i	25	29	15	23	33	12	29	13	32	11	20	9	23	14		Unit # 7
	f		f	105	110	80	90	85	85	85	85	85	85	95	80	90	90		power cord
			d	90	85	75	85	80	90	85	80	80	75	80	70	85	80		connectors exposed
9	i	9 TB	i	110	85	75	95	75	85	80	85	85	60	75	65	80	85		
	f		f	90	80	75	60	80	70	70	70	70	75	60	60	80	65		
			d																
10	i KA 10-14	10	i																
	f KA 10-26		f																
			d																
Investigator Initials & Date			i	KA	10-14	KA	10-16	KA	10-17	KA	10-18	KA	10-19	KA	10-20	KA	10-21		
			f	KA	10-15														
			d	KA	10-15														

i = initial   f = final   d = difference   * = spillage   + = water in bowl   @ =

WEI-98260

CO/PROJECT # WEI-98260
GROUP ID 11
TEST MATERIAL Unitech 500 (Pre)

BIOCENOTICS DATA FORM A.7

% ACTIVE NA
PLACEBO NA

DATA SHEET 2 OF 2
SPECIES [illegible]
TEST PERIOD 10-14-98/10-26-98
DC = Purina 5001 Meal
DOD = Day of Death

DAILY CONSUMPTION (G)

Animal #/Sex/Wt	Bowl #/Material/Wt		6 @	6 5	7 @	7 5	8 @	8 5	Pat-20 9 @	9 5	10 @	10 5	DOD	Comments
1M i	1 EPA	i	336.0	337.0	334.0	335.5	332.1	333.9	330.3	332.6	319.2	320.2		
f		f	334.0	335.5	332.1	333.9	330.3	332.6	319.2	320.2	318.3	318.0		
		d	2.0	1.5	1.9	1.6	1.8	1.3	1.1	2.4	0.9	2.2		
2 i	2 TB	i	7	5	10	12	3	9	2	7	7	7		
f		f	55	55	70	60	53	49	70	70	60	70		
		d	41	17	31	48	33	43	17	75	44	39		
3 i	3 TB	i	55	60	80	65	70	85	59	80	70	80		
f		f	70	25	95	55	75	15	65	70	75	6		
		d												
4M i	4 EPA	i	330.0	333.2	328.1	332.7	326.3	332.1	325.5	330.9	324.8	329.3		
f		f	328.1	332.7	326.3	332.1	325.5	330.9	324.8	329.3	323.8	327.8		
		d	1.9	0.5	1.8	0.6	0.8	1.2	0.7	1.6	1.0	1.5		
5 i	5 TB	i	6	19	13	9	11	9	10	9	9	9		
f		f	90	70	80	70	75	70	85	90	110	85		
		d	80	75	85	60	85	38	65	85	80	85		
6 i	6 TB	i	60	65	75	65	80	55	90	75	80	75		
f		f	95	60	85	70	75	80	75	85	85	80		
		d												
7M i	7 EPA	i	328.7	334.0	326.2	333.8	325.0	332.2	323.7	330.7	322.2	329.2		
f		f	326.2	333.8	325.0	332.2	323.7	330.7	322.2	329.2	321.1	327.6		
		d	2.5	0.2	1.2	1.6	1.3	1.5	1.5	1.5	1.1	1.6		
8 i	8 TB	i	20	9	43	4	37	4	29	18	20	24		
f		f	95	85	225	85	110	90	100	85	90	95		
		d	90	80	225	80	115	85	90	75	85	80		
9 i	9 TB	i	85	80	120	85	95	70	85	80	85	85		
f		f	90	60	95	70	90	80	80	80	85	75		
		d												
10 i	10	i												
f		f												
		d												
Investigator Initials & Date		i	KA	10-22	KA	10-23	KA	10-24	KA	10-25	KA	10-26		
		f												
		d												

i = initial f = final d = difference * = spillage + = water in bowl @ =

WEI-98260

CO/PROJECT # WEI-98260
GROUP ID #1
TEST MATERIAL Weitech 500 (Pcs)

BIOCENOTICS DATA FORM A.7

% ACTIVE NA
PLACEBO NA

DATA SHEET 1 OF 2
SPECIES M. musculus
TEST PERIOD 9-10-98 / 9-22-98

3C = Purina 5001 Meal
DOD = Day of Death

Pre-2d / Test 2d — DAILY CONSUMPTION (G)

Animal #/Sex/Wt		Bowl #/Material/Wt		-1 Q	-1 S	0 Q	0 S	1 Q	1 S	2 Q	2 S	3 Q	3 S	4 Q	4 S	5 Q	5 S	DOD	Comments
1F	i 16.4	1 EPA	i	345.6	347.6	344.7	346.6	344.2	345.4	342.2	345.3	341.0	345.1	339.1	345.1	337.0	345.0		
	f 16.0		f	344.7	346.6	344.2	345.4	342.7	345.3	341.0	345.1	339.1	345.1	337.0	345.0	335.6	345.0		
			d	0.9	1.0	0.5	1.2	1.5	0.1	1.2	0.2	1.9	0.0	2.1	0.1	1.4	0.0		
2	i	2 TB	i																Unit # 5
	f		f	140	120	95	90	105	95	105	80	95	70	85	70	85	65		
			d	95	105	70	110	80	90	80	85	90	65	80	75	60	31		
3	i	3 TB	i	110	90	85	80	75	75	90	75	85	70	75	60	65	18		
	f		f	105	95	120	85	90	75	95	70	90	48	80	65	61	50		
			d																
2F	i 15.9	4 EPA	i	353.2	346.5	352.3	345.9	351.7	344.8	350.4	344.2	349.3	343.6	347.9	343.1	346.4	342.9		
	f 14.9		f	352.3	345.9	351.7	344.8	350.4	344.2	349.3	343.6	347.9	343.1	346.4	342.9	345.0	342.6		
			d	0.9	0.6	0.6	1.1	1.3	0.6	1.1	0.6	1.4	0.5	1.5	0.2	1.4	0.3		
5	i	5 TB	i																Unit # 6
	f		f	110	100	80	70	85	80	75	65	75	75	65	58	60	70		
			d	85	70	65	29	70	43	66	53	49	56	21	50	26	52		
6	i	6 TB	i	90	70	65	75	65	70	49	80	45	34	40	26	65	50		
	f		f	60	85	70	44	60	60	75	65	70	42	40	46	55	70		
			d																
3F	i 14.1	7 EPA	i	348.4	344.5	347.9	343.1	347.1	342.5	345.8	341.8	344.4	341.5	342.7	340.9	340.9	340.7		
	f 15.6		f	347.9	343.1	347.1	342.5	345.8	341.8	344.4	341.5	342.7	340.9	340.9	340.7	338.8	340.6		
			d	0.5	1.4	0.8	0.6	1.3	0.7	1.4	0.3	1.7	0.6	1.8	0.2	2.1	0.1		
8	i	8 TB	i																Unit # 7
	f		f	90	120	85	85	85	65	85	95	60	90	75	65	60	65		
			d	80	70	80	75	57	48	51	72	60	45	65	61	38	37		
9	i	9 TB	i	65	75	60	75	85	42	60	38	27	49	55	48	55	24		
	f		f	48	80	80	85	55	54	60	75	17	65	70	38	55	40		
			d																
10	i KA 9-10	10	i																
	f KA 9-22		f																
	9-10		d																
Investigator Initials & Date			i	KA	9-10	KA	9-12	KA	9-13	KA	9-14	KA	9-15	KA	9-16	KA	9-17		
			f	KA	9-11														
			d	KA	9-11														

i = initial f = final d = difference * = spillage + = water in bowl @ =

WEI-98260

CO/PROJECT # WEI-98260
GROUP ID III
TEST MATERIAL Whitetail 500(Paste)

BIOCENOTICS DATA FORM A.7

% ACTIVE NA
PLACEBO NA

DATA SHEET 2 OF 2
SPECIES White-tailed deer
TEST PERIOD 9-10-98/ 9-22-98

SC = Purina 5001 Meal
DOD = Day of Death

DAILY CONSUMPTION (G)
Part-26

Animal #/Sex/Wt		Bowl #/Material/Wt		6 Q	S	7 Q	S	8 Q	S	9 Q	S	10 Q	S					DOD	Comments
1F	i	1 EPA	i	335.6	345.0	333.7	345.0	333.0	344.9	330.1	344.9	328.6	344.4						
	f		f	333.7	345.0	333.0	344.9	330.1	344.9	328.6	344.4	326.8	344.1						
			d	1.9	0.0	1.7	0.1	1.9	0.0	1.5	0.5	1.8	0.3						
2	i	2 TB	i																
	f		f	80	70	85	75	95	90	95	100	100	115						
			d	65	55	55	60	80	47	70	80	70	60						
3	i	3 TB	i	65	60	55	44	80	51	41	75	34	75						
	f		f	65	55	65	50	85	46	60	75	70	70						
			d																
2xF	i	4 EPA	i	345.0	342.6	343.3	342.4	342.5	341.6	341.3	340.9	340.1	339.7						
	f		f	343.3	342.4	342.5	341.6	341.3	340.9	340.1	339.7	339.0	339.0						
			d	1.7	0.2	0.8	0.8	1.2	0.7	1.2	1.2	1.1	0.7						
♂	i	5 TB	i																
	f		f	65	65	44	65	52	75	50	70	53	80						
			d	39	35	39	35	40	44	48	43	52	35						
♂	i	6 TB	i	55	60	60	65	46	48	26	41	53	40						
	f		f	50	55	42	38	42	26	46	28	55	30						
			d																
3xF	i	7 EPA	i	338.8	340.6	337.1	340.4	335.0	340.3	333.2	340.2	331.4	340.2						
	f		f	337.1	340.4	335.0	340.3	333.2	340.3	331.4	340.2	329.2	340.2						
			d	1.7	0.2	2.1	0.1	1.8	0.0	1.8	0.1	2.2	0.0						
♂	i	8 TB	i																
	f		f	65	65	60	60	80	90	80	85	70	85						
			d	55	18	80	70	43	58	80	85	60	48						
♂	i	9 TB	i	55	41	65	65	39	52	75	45	57	65						
	f		f	34	47	55	60	55	51	85	55	41	60						
			d																
♂	i	10	i																
	f		f																
			d																
Investigator Initials & Date			i	KA	9-18	KA	9-19	KA	9-20	KA	9-21	KA	9-22						
			f																
			d																

i = initial f = final d = difference x = spillage + = water in bowl @ =

BLACK&DECKER

Wild House Mice

Executive Summary of Tests Results

Applica™

Applica Consumer Products, Inc.

EXECUTIVE SUMMARY OF TEST RESULTS

Results of tests performed recently by an independent laboratory found that a Weitech electronic pest repeller was effective in repelling mice by reducing both their activity and food consumption.

The tests were performed by BioCenotics of Osseo, Michigan, an EPA and Health Canada approved testing laboratory. The tests were performed on wild house mice (mus musculus), the species most common throughout North America.

The tests were done with two feed chambers and one nesting chamber, per the enclosed description. During the pre, and post treatment period, both food consumption and activity were equal in the feed chambers. During the treatment period (Weitech electronic pest repeller "on") food consumption and activity was five times (5x) greater in the untreated chamber. The mice simply left the area in which the Weitech unit was "on".

The results of this test exceed EPA suggested performance standards for laboratory evaluation of ultrasonic devices and this confirms that Weitech's electronic pest repellers are an effective means of controlling and eliminating mice in home, offices and warehouses.

For further information contact:

Weitech, Inc. Customer Service 800-343-2659	or	BioCenotics A. D. Ashton 517-523-3441

Enclosure: Entire text of BioCenotics laboratory evaluation.

Wild Norway Rats

Laboratory Evaluation of
Ultrasonic Devices:
Weitech Transonic® Cix Heavy-Duty Commercial Electronic Pest Repeller

Applica Consumer Products, Inc.

Laboratory Evaluation of Ultrasonic Devices:
Weitech Transonic® Cix Heavy-Duty Commercial Electronic Pest Repeller on wild Norway rat (*Rattus norvegicus*)

BioCenotics Project # WEI-98009

Issue date: January 29, 1998

Prepared for: Weitech, Inc.
Author: A. Daniel Ashton

Weitech

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World leader in electronic pest control. Manufacturer of Transonic®, Bird Gard® and Yard Gard®.

EXECUTIVE SUMMARY OF TEST RESULTS

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Table of Contents

Laboratory Evaluation of Ultrasonic Devices
Project #: WEI-98009

Objective

Testing evaluated the performance of the Weitech Transonic® Cix Heavy-Duty Commercial Electronic Pest Repeller on wild Norway rats *(Rattus norvegicus).*

Methodology

Species:	wild Norway rat *(Rattus norvegicus)*
Number/sex:	six rats per test (two replicates of 3 rats per replicate)
Length of test:	7 days per replicate
Device on:	Days 3 through 6

Candidate test animals were held under laboratory conditions for at least seven days of observation prior to test initiation. Animal hearing was checked prior to testing by observation for Preyer's Reflex--a reaction to a loud noise. Test animals were individually housed in an apparatus. Three apparatuses were used for each replication; two replications comprised the test. Each apparatus consisted of four chambers (treated, untreated, nest, and connecting), configured in a T-formation.

The treated and untreated chambers each contained a single food bowl. The nest chamber contained a wooden nest box and cotton nesting material. Food and water were provided *ad libitum* throughout the study.

Output of all components of the ultrasonic system was performed (Phase 1). The Weitech Transonic® Cix Heavy-Duty Commercial Electronic Pest Repeller was then installed in the test apparatus and sound levels measured at specific sites inside the apparatus (Phase 2).

A rat was placed in a test apparatus with food provided in the treated and untreated chambers—one containing the ultrasonic test device and the other containing no test device—for seven days (Phase 3). The ultrasonic device was activated at 48 hours post placement and deactivated after Day 6 and the rat was removed after Day 7. See attached Protocol for further details.

Results

Phase 1—Device Measurements

Sound patterns (frequency and amplitude) were consistent for each of four Weitech Transonic® Cix Heavy-Duty Commercial Electronic Pest Repeller units. The primary source of the total sound output was in ultrasonic frequencies ranging from 25-40 kHz. Readings for the four units at all available settings are presented in Table 1. Changing the switch settings from quiet to medium increased sound pressure in the lower frequencies, a feature claimed in the manufacturer's literature. Additionally, moving settings from A to B to C generally increased sound pressure in the 10-20 kHz range.

Phase 2—Apparatus Measurements

Units were installed in three separate apparatuses. The amplitude in the treated chamber was >97 dB in each apparatus, while the difference between the treated and untreated chambers was >33 dB. Sound from the ultrasonic unit was generally confined to the treated chamber, with only slightly higher readings in the connecting chamber. Sound amplitude in the nest and untreated chambers was equivalent to background noise level.

Phase 3—Animal Observations

Food consumption in the treated chambers represented approximately 36% of the total food consumed during pre-treatment (Table 3). Food consumption in the treated chambers declined to only 7.4% of the total food consumed during the treatment period. Consequently, food consumption was reduced 82.6% in the treated chambers and increased 19.5% in the untreated chambers. The ratio of food consumption in the treated versus untreated chambers was approximately 1:1 during post treatment.

A decrease in rodent tracking board activity also was noted on Day 1 of treatment (Table 4). The trend was consistent throughout the four days of treatment. Changes in tracking board activity paralleled changes in food consumption throughout all phases of the test. Tracks in treated chambers accounted for 46.6% of totals during pre-treatment. This proportion was reduced to 30.9% during the treatment phase, while average tracking board activity decreased 63.4% in the treated chambers during the treatment phase. Post-treatment tracking board activity returned to pre-treatment levels. No rats exhibited any apparent hearing loss during the test.

Food consumption and tracking board activity measures both demonstrated repellency of greater than 60%, an EPA-suggested performance standard for laboratory evaluation of ultrasonic devices. However, it should be noted that efficacy of ultrasonic devices cannot be quantitatively compared to efficacy of rodenticides. A rodenticide kills a test subject and therefore removes it from the population, while an ultrasonic device may repel a rodent without removal from the population. Statistically, this represents sampling without replacement (rodenticide) versus sampling with replacement (ultrasonic). Additionally, no information exists by which a standard can be established. Replication of this test would be worthwhile and desirable.

Tables

Table 1. Sound pressure measurements (dB at 1 meter) of four Weitech Transonic® Cix Heavy-Duty Commercial Electronic Pest Repeller (no serial numbers) at selected frequencies (kHz), background range in parentheses.

Setting	Unit No.	Linear (56-64)	40 kHz (38-39)	31.5 kHz (38-38)	25 kHz (36-38)	20 kHz (36-37)	16 kHz (36-37)	12.5 kHz (36-37)	10 kHz (36-40)	8 kHz (36-40)
A-loud	1	98	96	92	94	79	73	73	75	74
	2	102	102	94	93	78	70	73	76	71
	3	103	103	97	92	77	73	73	78	76
	4	103	103	95	95	79	73	75	78	74
A-medium[a]	1	98	96	91	94	77	69	67	68	65
	2	102	102	94	93	76	67	67	69	62
	3	103	102	96	95	77	72	71	71	67
	4	103	103	95	95	77	69	69	70	65
A-quiet[a]	1	100	99	89	91	73	57	48	51	47
	2	102	102	91	87	73	58	49	47	47
	3	103	103	94	86	71	58	49	47	46
	4	105	105	94	91	74	60	56	62	53
B-loud[a]	1	100	97	94	94	82	78	79	83	83
	2	102	101	94	94	82	76	82	84	81
	3	104	102	97	92	81	79	81	85	85
	4	103	103	95	95	83	79	83	85	82
B-medium	1	97	95	90	93	81	73	70	72	69
	2	99	97	92	91	79	71	72	73	67
	3	100	100	94	89	78	73	71	74	70
	4	101	92	93	94	82	80	81	80	79
B-quiet[a]	1	97	97	87	89	77	63	50	50	52
	2	99	99	89	86	76	61	51	47	46
	3	101	101	101	84	74	62	53	51	49
	4	103	103	91	88	77	64	68	56	63
C-loud	1	105	97	91	94	87	84	88	87	76
	2	104	101	94	94	86	83	86	89	76
	3	106	102	97	92	84	85	86	89	76
	4	105	103	95	95	93	86	88	92	75
C-medium	1	97	93	93	92	87	78	79	78	67
	2	98	97	92	91	85	78	77	80	66
	3	100	99	94	88	81	80	77	80	76
	4	100	98	95	92	84	80	79	82	67
C-quiet	1	97	95	87	88	84	64	55	52	52
	2	98	98	88	86	84	67	57	53	47
	3	100	100	90	84	80	68	56	54	50
	4	101	101	91	87	82	68	57	56	37

[a] Unit can be adjusted to these settings, but they are not used in any application

Table 2. Sound measurements (dB) at selected points in test apparatuses; background at all points = 64 dB

	Untreated chamber	Connecting chamber		Treated chamber	Nest chamber
		Portal to untreated chamber	Portal to treated chamber		
Apparatus 1	64	67	67	97	64
Apparatus 2	64	66	67	98	64
Apparatus 3	64	67	68	101	64
Mean	64	67	67	99	64

Table 3. Daily food consumption (grams) by wild Norway rats *(Rattus norvegicus)* in chambers of test apparatuses.

		Body weight (g)		Pre-treatment				Treatment								Post treatment	
				DAY 1		DAY 2		DAY 1		DAY 2		DAY 3		DAY 4		DAY 1	
Animal	Sex	Initial	Final	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated
1M	M	278	298	11.5	8.1	9.8	3.4	14.0	0.2	14.3	0.0	11.6	2.0	10.4	2.2	4.1	11.1
2M	M	209	161	0.1	0.2	0.0	0.1	0.2	0.0	0.2	0.2	0.1	0.6	5.5	5.7	10.0	0.0
3M	M	228	227	11.4	9.2	9.0	7.7	7.5	0.1	10.1	0.4	9.4	0.0	8.1	0.2	4.8	5.9
1F	F	306	313	10.7	6.7	11.0	4.6	17.9	0.0	12.0	0.0	19.6	0.0	14.2	0.0	1.3	10.3
2F	F	245	250	9.8	7.9	9.0	2.8	11.4	3.0	11.3	2.4	13.1	0.4	11.1	0.7	7.6	5.5
3F	F	172	164	6.6	3.6	10.1	1.5	10.3	0.1	8.4	0.1	10.5	0.2	3.4	0.0	3.7	0.3
Mean				8.3	5.9	8.1	3.3	10.2	0.6	9.4	0.5	10.7	0.5	8.8	1.5	5.3	5.5

Table 4. Mean daily activity index of wild Norway rats *(Rattus norvegicus)* in test apparatus.[a]

	Pre-treatment				Treatment								Post treatment	
	Day 1		Day 2		Day 1		Day 2		Day 3		Day 4		Day 1	
Animal No.	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated
1M	64	53	66	23	33	0	20	0	25	7	19.	11	13	23
2M	65	43	56	24	27	0	30	15	72	21	22	16	31	0
3M	83	80	81	74	59	31	53	28	85	44	60	57	50	36
1F	47	82	50	43	22	0	30	0	48	0	35	0	17	44
2F	99	99	60	76	81	53	99	49	99	50	49	30	45	46
3F	99	85	68	49	67	17	68	12	53	5	26	0	13	1
Mean of means	76	74	64	48	48	17	50	17	64	22	35	19	28	25

[a] see Appendix A for description of index.

Protocol

PROTOCOL

TITLE: LABORATORY EVALUATION OF ULTRASONIC DEVICES
(Weitech Transonic Cix on wild Norway rat)

Project #: WEI-98005

1. Objective: Testing will evaluate the performance of the Transonic® Cix Heavy-Duty Commercial Electronic Pest Repeller on wild Norway rats (*Rattus norvegicus*).

2. Sponsor: Weitech, Inc.
251 West Barclay Drive
P. O Box 1659
Sisters, OR 97759
phone: 541.549.0205
fax: 541.549.8154

3. Test Facility: BioCenotics, Inc.
4880 Hudson Road
P. O. Box 117
Osseo, MI 49266-0117
phone: 517-523-3441
fax: 517-523-3052

4. Proposed Start Date: January 12, 1998
Proposed Completion Date: January 26, 1998

5. Authorization:

Stewart Weitzman 1/9/98
Stewart Weitzman Date
President
Weitech, Inc.

A. Daniel Ashton 1/9/98
A. Daniel Ashton Date
Study Director
BioCenotics, Inc.

6. Test Devices:

A. Device/System Tested: Name:/Model #: Transonic® CIX Heavy-Duty Commercial Electronic Pest Repeller

B. Sound Measurement Equipment: Bruel Kjaer brand.

NOTE: It will be the responsibility of the sponsor to characterize all materials supplied for testing, and also to establish any special usage, safety, handling, stability, or storage instructions. An MSDS will be provided (if available) for all test materials prior to test initiation.

7. Test System:

Species:

1. Norway rat (*Rattus norvegicus*) - wild caught. This rat species is one of the vertebrate species that the product literature claims this device will repel.
2. Number/Sex: six (6) rats per test.
3. ~~Weights: 100+ g. (adult).~~

8. Experimental Design: Test apparatus: Each apparatus consists of 4 wooden chambers (2'W x 2'D x 2'H) with removable Plexiglas lids interconnected by 4' sections of 2" clear plastic tubing. The chambers are configured in a T-formation; one central chamber connects to the other three chambers at 90 degree angles.

The floor of each chamber is covered with absorbent bedding material. Two carpet-covered bricks provide sound dampening in the central nest chamber. One carpet-covered brick is located ca. four inches from the passageway portal connecting the central and treated chambers. The second brick is located ca. four inches from the opposite passageway portal connecting the central and untreated chambers. The bricks restrict the ultrasonic sound to the treated chamber and treated-side passageway.

The treated and untreated chambers each contain a single food bowl with challenge diet. The fourth chamber (a nest chamber) contains a wooden nest box and cotton nesting material. A quart-size gravity feed waterer is located on top of the nest box. Food and water will be provided *ad libitum* throughout the study.

Setup: Candidate test animals are held under laboratory conditions for at least 7 days of observation prior to test initiation. Animal hearing is checked by observation for Preyer's Reflex, a reaction to a loud noise. Only animals demonstrating normal hearing are used in the study. Test animals are individually housed in an apparatus. Three apparatuses are used for each replication; two replications comprise a test. Lights in the test room are on a 12/12 hour light/dark cycle.

TEST PHASES:

Phase 1 (Device Measurements): Measurement of all components of the ultrasonic system under evaluation is performed utilizing a Bruel Kjaer ultrasonic sound meter. The system set up will follow the manufacturers product literature. All units are measured individually for sound output (both intensity in dB and frequency in Hz). Sound measurements will be performed at the standard 1 meter distance. Only devices meeting manufacturers specifications will be used for the study.

Phase 2 (Apparatus Measurements): Ultrasonic devices are installed in the treated chamber box of the test apparatus following the written instructions of the manufacturer. The apparatus is measured for sound levels at specific sites inside the apparatus: 1) exit portal of the treated chamber; 2) connecting chamber treated-side portal; 3) connecting chamber untreated-side portal; 4) exit portal of the untreated chamber; and 5) exit portal of nest chamber. Sound intensity and frequency are recorded at each of these five locations for two conditions--background (ultrasonic device off) and operational (ultrasonic device on).

These readings are used to confirm:

1. Ultrasonic sound is limited to the treated chamber and treated-side passageway.
2. The amplitude (sound intensity, dB) in the treated chamber must be equal to or greater than the specifications listed in the manufacturers product literature.
3. The amplitude in the untreated chamber should be close to background noise, regardless if the ultrasonic system is on or off.
4. Amplitude differential between treated and untreated chambers must be at least 15 dB.

Phase 3 (Animal observations): Three individually housed animals comprise one replication; two replicates comprise a test. Each replication will run for 7 days: two days of pretreatment observation; four days of treatment observation (ultrasonic device on); and one or two days of post-treatment observation. (A second day of post-treatment observation will be added if first day observations are inconsistent between animals.)

Pretreatment: Animals are weighed, placed in an apparatus and allowed to acclimate for two days. Food is provided and consumption is recorded daily. Tracking boards will be placed under the portals to the passageways, and centered along each side of both the treated and untreated chambers. Rodent tracks will be counted and boards replaced daily. Observations of rat behavior within the apparatus also are recorded.

Treatment: The ultrasonic system is turned on and daily food consumption, tracking data, and rat behavior observations are recorded for four days.

Post-treatment: The ultrasonic system is turned off; daily data collection and observations are continued for one or two additional days. Animals are removed, weighed, evaluated for fitness, and tested for Preyer's Reflex. The latter is used to determine if any damage to animal hearing occurred during the study.

9. Challenge Diet: EPA (65% ground corn, 25% ground steam rolled oats, 5% corn oil, and 5% powdered sugar).

10. Control Group: This test format allows for use of pretest and post-test data as an internal control for test group animals. Data collected when the ultrasonic system is on is compared with data collected when this system is off. Use of this form of control mitigates against variation in test results due to animal behavior variability.

11. Other Considerations:

A. Any special safety, handling, use, or installation procedures identified in the manufacturer's product literature will be followed during this study.

B. Efficacy Criteria: No efficacy criteria are required for this test. However, the EPA suggests performance standards under laboratory and field conditions for devices should produce repellencies of 60% or greater.

C. Disposition of Animals: Animal health status will be evaluated at conclusion of the study, and healthy animals will be labeled and retained for future testing, while any unhealthy animals will be euthanized by cervical dislocation.

12. Statistical Methodology: None.

Results will be reported in tables and/or graphs of test unit efficacy as demonstrated by:

1. sound reading results for the Transonic® Cix units
2. sound reading results for the installed Transonic® Cix units in the test apparatus
3. daily animal food consumption data results
4. daily animal tracking census data results
5. daily rat behavior observation results

13. Data Storage: All raw data and copies of the final report are stored at BioCenotics, Inc., Osseo, MI.

14. References:

A. Canadian Ultrasonic Device Protocol (1984).
B. EPA (1993). Ultrasonic device protocol guidelines.
C. EPA Good Laboratory Practice Standards (40 CFR, Part 160).
D. Guide for the Care and Use of Laboratory Animals (1996), National Research Council, National Academy Press, Washington, D. C.
E. IEC free field sound measurement standard.
F. OSHA human sound exposure guidelines for continuous/intermittent sound under 20kHz.

15. Amendments: NA.

APPENDIX A

Daily tracking board observation index

The following index was used to report tracking board observations. Tracks were counted or estimated and the mean for the appropriate class was used for data analysis.

Tracks counted	Mean
0	0
1-5	3
6-10	8
11-19	15
20-28	24
29-41	35
42-54	48
56-71	63
72-88	80
>88	99

Data

SONIC EQUIPMENT TEST FORM

Company: WEITECH, INC
Project #: WEI-97333
Date: 11-5-97

MEASUREMENT EQUIPMENT
Meter: BK-2209
Filter: BK-1616
Microphone: BK-4135
Weighting Network: EXTERNAL FILTER
Detector Response: NORMAL / FAST
Standard: I.E.C.

EQUIPMENT CALIBRATION
Calibrated by: B+K
Date:

TEST MATERIALS
Name: TRANSONIC CIX
Model #: 0600
Serial #: N-A (OVA #)
Other Components: ~~OVA #1~~

Sound Type:

ENVIRONMENTAL CONDITIONS: ☒ Indoor ☐ Outdoor
Sound Field: FREE
Temperature: 75 °F
Humidity: 29 %

Location: BIOCENOTIC · SW
Comments:

Investigator: T. BRYANT

SONIC EQUIPMENT MEASUREMENTS

Sound Pressure Level (dB) measured at __ meters:

Frequencies (kHz)	linear	40	31.5	25	20	16	12.5	10	8
Background	64	38	38	36	36	36	36	40	40
~~EQUIPMENT~~ SETTING TESTED									
A - QUIET	100	99	89	91	73	57	48	51	47
A - MEDIUM	98	96	91	94	77	69	67	68	65
A - LOUD	98	96	91.5	93.5	78.5	72.5	72.5	74.5	74
B - QUIET	97	96.5	86.5	89	76.5	63	50	50	52
B - MEDIUM	97	94.5	89.5	92.5	81	73	70	72	69
B - LOUD	99.5	96.5	93.5	93.5	82	78	79	82.5	83
C - QUIET	97	95	87	88	83.5	64	54.5	52	52
C - MEDIUM	97	95	93	92	86.5	78	79	78	67
C - LOUD	104.5	96.5	91	94	87	84	88	87	75.5

WEI-98009

Data Sheet 1 of 1

SONIC EQUIPMENT TEST FORM

Company: WEITECH, INC
Project #: WEI-97333
Date: 11-10-97

MEASUREMENT EQUIPMENT
Meter: BK-2209
Filter: BK-1616
Microphone: BK-4135
Weighting Network: EXTERNAL FILTER
Detector Response: NORMAL / FAST
Standard: I.E.C.

EQUIPMENT CALIBRATION
Calibrated by: B+K
Date:

TEST MATERIALS
Name: TRANSONIC CIX
Model #: 0600
Serial #: N-A (OUR #2)
Other Components:

Sound Type:

ENVIRONMENTAL CONDITIONS. ☒ Indoor ☐ Outdoor
Sound Field: FREE
Temperature: 74.0 F
Humidity: 22 %

Location: BIOCENOTIC SW
Comments:

Investigator: T. BRYANT

SONIC EQUIPMENT MEASUREMENTS
Sound Pressure Level (dB) measured at __ meters

Frequencies (kHz)	linear	40	31.5	25	20	16	12.5	10	8
Background	56	38	38	78	37	36	36	36	36
SETTING ~~EQUIPMENT~~ TESTED									
A - QUIET	102	102	90.5	87	73	58	49	47	47
A - MEDIUM	102	102	94	92.5	75.5	66.5	66.5	68.5	62
A - LOUD	102	102	94	93	77.5	70	72.5	76	71
B - QUIET	99	99	89	85.5	76	61	50.5	46.5	45.5
B - MEDIUM	99	97	92	91	79	71	72	73	67
B - LOUD	102	101	94	97.5	81.5	76	81.5	84	80.5
C - QUIET	98	98	88	85.5	83.5	66.5	56.5	52.5	46.5
C - MEDIUM	98	97	92	90.5	84.5	78	76.5	79.5	66
C - LOUD	104	100.5	94	93.5	85.5	83	85.5	89	76

WEI-98009

SONIC EQUIPMENT TEST FORM

Company	WEITECH, INC
Project #	WEI - 97333
Date	11-10-97

MEASUREMENT EQUIPMENT

Meter	BK-2209
Filter	BK-1616
Microphone	BK-4135
Weighting Network	EXTERNAL FILTER
Detector Response	NORMAL / FAST
Standard	I.E.C.

EQUIPMENT CALIBRATION

Calibrated by	B+K
Date	

TEST MATERIALS

Name	TRANSONIC CIX
Model #	0600
Serial #	N-A (ovn #3)
Other Components	

Sound Type	

ENVIRONMENTAL CONDITIONS ☒ Indoor ☐ Outdoor

Sound Field	FREE
Temperature	74.0 F
Humidity	22 %

Location	BIOCENOTIC SW
Comments	
Investigator	T. BRYANT

SONIC EQUIPMENT MEASUREMENTS

Sound Pressure Level (dB) measured at __ meters.

Frequencies (kHz)	linear	40	31.5	25	20	16	12.5	10	8
Background	56	38	38	38	37	36	36	36	36
~~EQUIPMENT~~ SETTING TESTED									
A - QUIET	103	103	94	86	71	58	49	47	46
A - MEDIUM	103	101.5	96	94.5	76.5	72	70.5	71	67
A - LOUD	103	103	96.5	92	76.5	72.5	73	77.5	75.5
B - QUIET	101	101	101	89	73.5	61.5	53	51	49
B - MEDIUM	100	100	94	89	78	73	71	74	70
B - LOUD	103.5	102	96.5	92	81	78.5	89.5	85	84.5
C - QUIET	100	100	90	83.5	80	67.5	56	54	50
C - MEDIUM	190	98.5	93.5	88	81	79.5	76.5	80	75.5
C - LOUD	105.5	101.5	96.5	92	83.5	84.5	86	89	75.5

WEI-98009

Data Sheet: 1 of 1

SONIC EQUIPMENT TEST FORM

Company: WEITECH, INC
Project #: WET-97333
Date: 11-11-97

MEASUREMENT EQUIPMENT
Meter: BK-2209
Filter: BK-1616
Microphone: BK-4135
Weighting Network: EXTERNAL FILTER
Detector Response: NORMAL / FAST
Standard: I.E.C.

EQUIPMENT CALIBRATION
Calibrated by: B+K
Date:

TEST MATERIALS
Name: TRANSONIC CIX
Model #: 0600
Serial #: N-A (OUR #4)
Other Components:

Sound Type:

ENVIRONMENTAL CONDITIONS ☒ indoor ☐ Outdoor
Sound Field: FREE
Temperature: 74.0 F
Humidity: 31 %

Location: BIOCENOTIC SW
Comments:

Investigator: T. BRYANT

SONIC EQUIPMENT MEASUREMENTS
Sound Pressure Level (dB) measured at: __ meter(s)

Frequencies (kHz)	linear	40	31.5	25	20	16	12.5	10	8
Background	64	39	38	38	37	37	37	37	36
~~EQUIPMENT~~ SETTING TESTED									
A - QUIET	105	105	93.5	91	73.5	60	55.5	61.5	52.5
A - MEDIUM	103	103	95	95	77	69	69	70	64.5
A - LOUD	103	103	95	95	78.5	73	75	78	74
B - QUIET	103	102.5	91.5	88	76.5	64	68	55.5	63
B - MEDIUM	101	92	93	94	82	79.5	80.5	80	79
B - LOUD	102.5	102.5	95	95	83	78.5	83	85	82
C - QUIET	101	101	91	87	82	68	57	56	37
C - MEDIUM	100	97.5	94.5	92	83.5	80	78.5	81.5	66.5
C - LOUD	105	102.5	95	95	92.5	85.5	88	91.5	74.5

WEI-98009

CO/PROJECT # Bc-98009

GROUP ID Group 1

TEST MATERIAL WEITECH TRANSONIC CIX

BIOCENOTICS DATA FORM

DATA SHEET 1 OF 1

SPECIES Rattus norvegicus

TEST PERIOD 1-9-98 1-16-98

ANIMAL #	wt./sex	TEST APPARATUS		PRE-TREATMENT DAY 1 Q	PRE-TREATMENT DAY 1 S	PRE-TREATMENT DAY 2 Q	PRE-TREATMENT DAY 2 S	TREATMENT DAY 1 Q	TREATMENT DAY 1 S	TREATMENT DAY 2 Q	TREATMENT DAY 2 S	TREATMENT DAY 3 Q	TREATMENT DAY 3 S	TREATMENT DAY 4 Q	TREATMENT DAY 4 S	POST TREATMENT Q	POST TREATMENT S	DOD	Comments
1	i 278	#1M	i	391.5	420.7	380.0	4126	3702	4092	3362	4090	3419	4090	3303	4070	3199	4048		
	f 298		f	380.0	412.6	3702	4092	3362	4090	3449	4090	3303	4070	3199	4048	3.158	3937		
			d	11.5	8.1	9.8	3.4	14.0	0.2	14.3	0.0	11.6	2.0	10.4	2.2	4.1	11.1		
		TRACKING BOARDS	1	6.7	80	80+	47	54	8	41	0	44	15	37	21	25	52		
			2	72	32	37	16	27	0	17	0	9	6	27	7	9	19		
			3	65	60	42	18	36	0	15	0	29	0	10	10	17	15		
			4	48	36	100+	14	24	0	14	0	12	5	10	3	2	12		
2	i 208.6	#2M	i	391.0	386.8	3909	3866	3909	3865	3907	3865	3905	3863	3904	3857	3849	3800		
	f 161		f	3909	3866	3909	3865	3907	3865	3905	3863	3904	3857	3849	3800	3749	3800		
			d	0.1	0.2	0.0	0.1	0.2	0.0	0.2	0.2	0.1	0.6	[illegible]	5.7	10.0	0.0		
		TRACKING BOARDS	1	100+	100+	100+	56	58	0	85	35	100+	38	34	42	85	0		
			2	17	22	9	10	1	0	10	9	85	7	14	3	14	0		
			3	42	32	34	12	29	0	18	8	85	28	20	9	14	0		
			4	100+	18	75	6	10	0	19	7	39	12	17	5	11	8		
3	i 228	#3M	i	393.4	392.1	3820	3829	3730	3752	3655	3751	3554	3747	~~3554~~ 3460	3747	3359	3745		
	f 227		f	3820	3829	3730	3752	3655	3751	3354	3747	3460	3747	3359	3745	33.1	3686		
			d	11.4	9.2	9.0	7.7	7.5	0.1	10.1	0.4	9.4	0.0	8.1	0.2	4.8	5.9		
		TRACKING BOARDS	1	100+	100+	85	55	90	54	80	51	100+	80	85	80	70	68		
			2	100+	100+	100+	80	54	31	47	28	62	33	60	62	42	29		
			3	100+	100+	85	36	57	22	50	18	88	23	47	34	34	20		
			4	30	22	65	90	38	19	38	27	94	34	42	28	40	19		
				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		

i = initial
f = final
d = difference
Q = UNTREATED
S = TREATED

WEI-98009

CO/PROJECT #: Bt-98009
GROUP ID: Group 2
TEST MATERIAL: WESTECH TRANSONIC CX

BIOCENOTICS DATA FORM

DATA SHEET 1 OF 1
SPECIES: Rattus norvegicus
TEST PERIOD: 1-18-98

ANIMAL #/wt./sex	TEST APPARATUS		PRE-TREATMENT Day 1 Q	Day 1 S	Day 2 Q	Day 2 S	TREATMENT Day 1 Q	Day 1 S	Day 2 Q	Day 2 S	Day 3 Q	Day 3 S	Day 4 Q	Day 4 S	POST TREATMENT Q	S	DOD:	Comments
1 i: 306 f: 313	#1F	i	3762	3847	3655	3780	3545	3734	3366	3734	3651	3734	3607	3734	3465	3734		
		f	3655	3780	3545	3734	3356	3734	3246	3734	3555	3734	3465	3734	3452	3631		
		d	10.7	6.7	11.0	4.6	17.9	0.0	12.0	0.0	19.6	0.0	14.2	0.0	1.3	10.3		
	TRACKING BOARDS	1	69	100+	51	100+	34	0	35	0	100+	0	48	0	12	75		
		2	53	85	45	21	13	0	34	0	20	0	27	0	29	30		
		3	19	44	32	19	20	0	31	0	33	0	42	0	6	79		
		4	66	100+	36	39	13	0	17	0	30	0	18	0	7	78		
2 i: 245 f: 250	#2F	i	3888	3810	3790	3731	3700	3731	3586	3701	3473	3677	3667	3673	3356	3666		
		f	3790	3731	3700	3703	3556	3701	3473	3677	3342	3673	3556	3666	3480	3611		
		d	98	7.9	90	2.8	11.4	3.0	11.3	2.4	13.1	0.4	11.1	0.7	7.6	55		
	TRACKING BOARDS	1	100+	100+	85	96	95	77	100+	52	100+	71	62	18	31	55		
		2	100+	100+	42	56	67	31	100+	38	100+	38	50	32	52	21		
		3	100+	100+	42	58	64	62	100+	100+	100+	100+	38	39	41	46		
		4	100+	100+	66	87	100	38	100+	19	100+	3	46	40	58	52		
3 i: 172 f: 164	#3F	i	3859	3802	3793	3766	3692	3751	3589	3750	3505	3749	3672	3747	3638	3747		
		f	3793	3766	3692	3751	3589	3750	3505	3749	3400	3747	3638	3747	3601	3744		
		d	6.6	3.6	10.1	1.5	10.3	0.1	8.4	0.1	10.5	0.2	3.4	0.0	3.7	0.3		
	TRACKING BOARDS	1	100+	90	100+	43	80	38	100+	32	86	19	51	0	32	5		
		2	100+	85	67	50	70	13	53	4	48	3	15	0	6	0		
		3	100+	85	65	31	67	4	62	5	53	4	23	0	0	0		
		4	100+	80	52	56	69	16	59	2	41	0	12	0	6	0		

i = initial
f = final
d = difference
Q = UNTREATED
S = TREATED

WEI-98009

BioCenotics, A Leader In Providing:

?esticide esearch and anufacturing Support

Daniel Ashton General Manager of BioCenotics, is a recognized authority in the areas of laboratory and field testing. He has an enviable record in evaluation as well as in establishing protocols and formulations

- ☐ Development of protocols for tests to support label and marketing claims
- ☐ Bait and formulation development
- ☐ Bioassay quality control testing of production lots
- ☐ Evaluation of bait stations, traps, ultrasonic units and other control devices for efficac in relationship to rodent behavior
- ☐ Shelf life testing
- ☐ Comparative testing of candidate bait formulations
- ☐ Rodenticide evaluation

Field and Laboratory Analysis for EPA Label Submissions

Key to the laboratory's success is its ability to meet the rigorous requirements of the EPA for efficacy and other label claims.

- ☐ LD50 determinations for technical rodenticides and LC50 determinations for pesticide baits
- ☐ Laboratory efficacy tests for single-feedin and multiple-feeding rodenticides
- ☐ Field efficacy tests of rodenticide formulations
- ☐ Testing to support label claims for control of anticoagulant resistant rats and mice
- ☐ Field testing to measure secondary toxicit and hazards to non-target species

Vertebrate Pest ntrol Consulting and Training

Dr. William B. Jackson, Chairman of BioCenotics, is an internationally renowned authority on vertebrate pest control. He has directed efforts throughout the world to control rodents in urban and agricultural areas.

- ☐ Integrated Pest Management (IPM)
- ☐ Rodent control workshops
- ☐ Expert witness support
- ☐ Rodenticide use training

Pesticide Marketing Support

- ☐ Consulting on vertebrate pest control
- ☐ Development of technical and training materials on product use
- ☐ Presentation of educational programs

Consultation on the Impact of Construction on Wildlife

The environmental impact of major development projects is a growing concern; the dislocation of rodent populations due to urban construction is an emerging issue.

- ☐ Environmental assessment
- ☐ Environmental management
- ☐ Vertebrate pest management strategies

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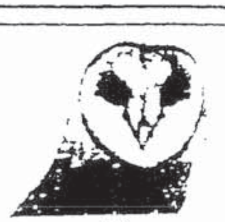

- ☐ Field testing
- ☐ Wildlife hazard evaluation
- ☐ Wildlife Monitoring
- ☐ Habitat enhancement design

Bowling Green State University

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Bowling Green, Ohio 43403-0212
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Dr. William B. Jackson, a Wisconsin native, gained his bachelor's and master's degrees from the University of Wisconsin and his Doctor of Science (Sc.D.) degree from the School of Hygiene and Public Health of The Johns Hopkins University. Jackson has had world-wide experience in vertebrate ecology and pest vertebrate management.

Initially as a graduate student, he was involved in the pioneering research program on the ecology of urban rats and the first field testing of Compound 42 (later to be called Warfarin) at The Johns Hopkins University in Baltimore. Later he was a Commissioned Officer in the U. S. Public Health Service with research and training responsibilities in vector control. This was followed by a 2-year assignment with the National Research Council on Ponape in the Eastern Caroline Islands of Micronesia studying tropical rodent populations.

In 1957 Jackson joined the faculty at Bowling Green State University in Ohio and moved through the academic and administrative ranks to be Director of the Center for Environmental Research and Services and Distinguished University Professor of Biological Sciences at the time of his official retirement in 1985. During the nearly three decades at Bowling Green he identified Warfarin resistance in the United States and established a laboratory to study its national distribution and develop counter measures, originated an applied biology curriculum for pest control majors, organized the Bowling Green Bird Control Seminars, trained nearly 100 graduate students in basic and applied ecology, returned numerous times to the South Pacific to study the response of rats to radiation at the atomic test sites on Bikini and Enewetak Atolls, directed grant programs with a value of nearly $2 million, and authored more than 200 technical and popular papers and book chapters. Many of his students were from developing countries and now hold responsible industry and government positions.

He has travelled extensively as a participant in international symposia and consultant for the World Health Organization and Food and Agriculture Organization of the United Nations, U. S. Agency for Internationl Development, and private foundations and corporations. He is a frequent consultant to the pest control and food processing industries.

Since retirement, he has formed (with several associates) BioCenotics Inc. of Osseo, MI, a testing laboratory and consulting group for pesticide and environmental research and development. Stocks of anticoagulant-resistant rats and mice were moved from the university, and the laboratory is uniquely capable of testing potential rodenticides and baits and control devices on wild rodents. Recently, the group has been asked to design a rodent management program for Boston's 10-year, multi-billion dollar Central Artery/Third Harbor Tunnel Construction project. Also involved are environmental assessments and measurements of environmental quality. He has continued to teach part-time at Bowling Green State University.

BLACK&DECKER

German Cockroaches

Responses of German Cockroaches to Ultrasound-Emitting Devices Designed to Repel Pests

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Responses of German Cockroaches to Ultrasound-Emitting Devices Designed to Repel Pests

Final Report

Results from year 2001

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The German cockroach, *Blattella germanica* (L.), is a serious household pest worldwide, and is an important public health pest. Ultrasonic devices have been tested in repelling cockroaches to verify manufacturer's claims of their effectiveness. In most cases, ultrasonic devices were found to be ineffective. In year 2000, we reported the efficacy tests of ultrasound emitted from three commercialized ultrasonic devices including Transonic Cix 0600 (also called Cix 0600), Transonic 100, and Transonic 800, to repel the cockroaches in the laboratory. In these tests, the ultrasonic units were mounted inside the test enclosures. The responses of the German cockroach to the ultrasound varied among the three ultrasonic devices. The ultrasound emitted from the device Cix 0600 at "A and Quiet" appeared to be able to partially, but significantly, repel the German cockroaches. Transonic 100 and Transonic 800 failed to repel the insects. The current report summarizes the efficacy tests of ultrasound emitted from four commercial ultrasonic devices including Cix 0600 at "A and quiet" and at "A and Loud", Transonic 800, a Sunbeam unit, and a Lentek unit to repel German cockroaches in the same test conditions as year 2000, but the ultrasonic units were mounted outside of the test enclosure and the tests were conducted beyond the usual 5 days. The sound patterns produced by these devices have been described in the cockroach and cricket test reports.

Materials and Methods

Insects. The German cockroach, *Blattella germanica* (L.), was obtained from the Department of Entomology, Kansas State University, Manhattan, Kansas. Cockroaches were reared on Pedigree® dog food (Kal Kan Foods, Vernon, California, U.S.A.) in 3.3-liter plastic containers with lids (Servin' Saver ™, Rubbermaid Home Products, Wooster, Ohio, U.S.A.). A plastic cup (6.5 cm diam x 6.0 cm high) was filled with water and a

cotton swab was placed in the vial to provide humidity. Cultures were held in the laboratory at 24–27 °C and 75-80% relative humidity.

Test enclosures. Four Plexiglas enclosures, each measuring 1.2 m x 1.2 m x 1.2 m, were constructed. A 6.5-cm diam hole was drilled at the top center of each enclosure. An ultrasonic unit was mounted outside of the hole. The speaker of the unit was fitted within the hole and faced directly to the bottom center of the enclosure. The inside surface around the hole (about 3 cm wide) was printed with white petroleum jelly (Allegan, MI) to prevent insects from reaching to or entering the openings near the speaker. Four commercial devices, Cix 0600, Transonic 100, Transonic 800, Sunbeam, and LenTek devices, were tested. A 91-cm long square conduit, measuring 7.6 cm^2, connected the two enclosures at the bottom front corner. Rectangular Plexiglas gates near the conduit junctions could be opened manually to allow insect movement between the enclosures.

Each device was tested separately. Tests were replicated three times with Cix 0600 at "A and Quiet" and Transonic 800, and 2 replications for Cix 0600 at "A and Loud". Sunbeam and Lentek devices were tested only once, with the intent that if results were positive, additional replications would be tested. In each replication, 100 unsexed nymphs and adults of mixed ages (80% nymphs and 20% adults) were released into each enclosure and allowed to acclimate for 24 h (day 0). The gates were opened during this time period to allow insects to freely move between enclosures. After 24 h, the device (Cix 600 "A and Quiet" or Transonic 800) in one of the enclosures was turned on for 7 d and then turned off (first 7-d test period). The ultrasonic unit in the other enclosure was then turned on for 7 d (second 7-day test period). This 15-d test (24 h + 14 d) constituted

a single replication. For Cix 0600 at "A and loud", Sundeam, and Lentek, 24 h after release of cockroaches into the enclosures, an ultrasonic unit in one of the enclosures was turned on for 2 d and then turned off (first 2-d test period). The ultrasonic unit in the other enclosure was then turned on for 2 d (second 2-day test period). This 5-d test constituted a single replication. This is similar to the tests we performed with cockroaches that were reported in year 2000. The number of cockroaches in each enclosure was counted daily between 10:00-11:00 a.m. After cockroach introduction, the enclosures were covered with black plastic sheets to exclude light. Plastic sheets were removed and the gates were closed temporarily to facilitate counting during the tests. A new group of cockroaches was used for each replicate. After each test, all insects were evacuated and the test enclosures and conducts were cleared. A new group of cockroaches was used for each replicate.

Microprocessor-based sensors (HOBO units, Onset Computer Corporation, Pocasset, Massachusetts, U.S.A.) were used to record temperatures and humidity levels within each enclosure. Temperature and relative humidity during all tests was 23-25°C and 64-83%, respectively.

Data analysis. No mortality of adults or nymphs was observed in any of the replicated trials. For the 15-day tests, data on changes in cockroach numbers in enclosures were calculated based on the number of insects found on days 1-7 minus the number of insects found on day 0 for the first 7-d test period. Similarly, the number of cockroaches found on days 8-14 was subtracted from the numbers found on day 7 for the second 7-d test period. For the tests with a 5-day period, data on the changes in cockroach numbers in an enclosure were calculated based on the number of insects found on days 1-

2 minus the number of insects found on day 0 for the first 2-d test period. Similarly, the number of cockroaches found on days 3-4 was subtracted from the numbers found on day 2 for the second 2-d test period. Changes in insect numbers were subjected to an analysis of variance in a strip split-plot design, using the PROC MIXED procedure of SAS (SAS Institute, 1996). The enclosure and first and second 2 or 7-day test periods were considered as the strip factors and whole plots, respectively. Each combination of the enclosure and test period was a subplot. Day was considered as a subplot within a test period. Treatments were assigned to interceptions of test periods and enclosures.

Results and Discussion

Raw data showing the number of cockroaches in each of the enclosures were shown in Tables 1-3. One day after insects were released into the enclosures, there were about 67- 78 cockroaches in the enclosures (Tables 1-3). Therefore, the cockroach population appeared to be relatively evenly distributed during the first 24 hours before ultrasonic units were turned on. The remaining cockroaches unaccounted for (not visible) in enclosures were in the conduits connecting the enclosures.

1. Results from ultrasonic Transonic Cix 0600 at "A and Quiet". Table 4 gives the changes in cockroach numbers in each enclosure over time. On average, the data showed a consistent decrease in the enclosure with an active ultrasonic unit and a consistent increase in the enclosure without the unit during the first 7-day period. The number of cockroaches in the enclosures with active ultrasonic units, on average, decreased by 17 individuals during the first 7-day test period (Table 4). Correspondingly, the number of cockroaches in the enclosures with inactive ultrasonic units increased by 14 individuals during this period. Results from the second 7-day test period were more

significant. During this period, the number of cockroaches in the enclosures with active ultrasonic units decreased by 23 individuals and in the enclosures without ultrasound increased by 34 individuals during this time period. A maximum number of cockroaches responded to ultrasound on the first day of the first or second 7-day test periods. There were no significant changes in cockroach numbers after this first day after ultrasonic units were turned on (Table 7).

2. Results from ultrasonic Cix 0600 "A and Loud". Table 6 gives the changes in number of cockroaches in each enclosure over time. The data were consistent and indicated that part of the cockroaches moved from the enclosures with ultrasound to the enclosures without ultrasound. On average, during the first 2-day test period, the number of cockroaches in the enclosure with an active ultrasonic units decreased by 23 individuals, whereas the cockroaches in the enclosure with an inactive ultrasonic unit increased by 30 individuals. In the second 2-day test period, cockroaches in the enclosure with an active ultrasonic unit decreased by 26 individuals. On the other hand, the cockroaches in the enclosure with an inactive ultrasonic unit increased by 22 individuals. Statistical analysis of the data showed that there were significant differences in the number of cockroaches found in the enclosures with active ultrasonic units compared to one without ($P<0.05$) (Table 7). The effect of test period and days within a test period were not significant ($P>0.05$) (Table 2). It appears that the response of the German cockroach to the ultrasound from Cix 0600 at "A and loud" was similar to the ultrasound from the same device at "A and Quiet" setting.

3. Results from ultrasonic Transonic 800. The data from the first 2 replications were more consistent compared to the data from the third replication (Table 5). On

average, during the first 7-day test period, the number of cockroaches in enclosures with an active ultrasonic unit decreased by 26 individuals. There was an increase of 12 cockroaches in the enclosure without ultrasound. In the second 7-day test, cockroaches in enclosures with active ultrasonic units decreased by 18 individuals. On the other hand, the number of cockroaches in the enclosures with inactive ultrasonic units increased by 24 individuals. These changes were observed during the first day of the first and second 7- day test period (Table 7). The effects of test period and the test duration within each test period were not significant (P>0.05) (Table 7). The results were different from the last year's data when the ultrasonic units were mounted inside the test enclosures.

4. Results from ultrasonic Sunbeam, and Lentek devices. Table 6 gives the changes in number of cockroaches in each enclosure over time. Clearly, the data showed that ultrasound from either of the devices could not repel German cockroaches. With Sunbeam, during the 4-day test period, the number of cockroaches in enclosures with an active ultrasonic unit increased by 1 insect, and the cockroaches in the enclosures with inactive ultrasonic units decreased by 7 insects. The results with Lentek units were similar to that of Sunbeam. No replications were conducted for the two devices because of the negative results.

In conclusion, the responses of German cockroaches to ultrasound varied among the four ultrasonic devices. The ultrasound emitted from Cix 0600 at both settings ("A and Quiet" and "A and Loud") and Transonic 800 appeared to significantly repel the German cockroaches. Both devices Sunbeam and Lentek failed to repel the insects. With device Cix 0600, similar results were obtained in the current tests compared to the results from year 2000's tests. However, with Transonic 800, the results presented here were

positive compared with those reported earlier. When the ultrasonic units were mounted inside the test enclosures as described in the earlier tests in 2000, many roaches accumulated on the units, especially in the collection area between ultrasonic units and the electronic cables. Each Cix 0600 unit accompanies with an electronic adopter. In preliminary tests we also found many cockroaches accumulated on the adopters when the adopters were put inside the enclosures. We noted that the adopters were warmed up when the units were plunged in and turned on. This might be the reason that the adopters attracted the cockroaches. The new experimental design eliminated these areas where cockroaches could hide. The positive results from the new experimental design indicate that ultrasound emitted from Cix 0600 or Transonic 800 units may have impacts on the movement of German cockroaches in the paired enclosures. However, in terms of field conditions, it may be difficult to isolate the ultrasonic units from the environments where the cockroaches need to be repelled. The ability of Cix 600 and Transonic 800 units to repel cockroaches may be due to the sound pressure created by these units or the frequencies. A neuro-physiological approach may shed light on why these cockroaches respond to certain sounds and not others, because cockroaches have not evolved organ systems for ultrasound detection or production. Sunbeam and Lentek produced very weak sound outputs, and perhaps, were not repellent to the cockroaches.

Table 1. Number of German cockroaches in each enclosure in tests with Cix 0600 "A and Quiet". Each test is a replication.

Date, and day	Unit in Enclosure		No. insects in A	No. insects in B	Remarks
	A	B			
First test					
06/18/01	Start	Start	100	100	Expt. Start
06/19/01,0	Off	Off	65	50	
06/20/01,1	On	Off	35	82	
06/21/01,2	On	Off	45	53	
06/22/01,3	On	Off	62	37	
06/23/01,4	On	Off	69	33	
06/24/01,5	On	Off	79	31	
06/25/01,6	On	Off	74	32	
06/26/01,7	On	Off	64	35	
06/27/01,8	Off	On	87	23	
06/28/01,9	Off	On	96	20	
06/29/01,10	Off	On	98	14	
06/30/01,11	Off	On	89	11	
07/01/01,12	Off	On	85	18	
07/02/01,13	Off	On	83	20	
07/03/01,14	Off	On	82	14	
Second test					
07/03/01	Start	Start	100	100	Expt. Start
07/04/01,0	Off	Off	87	112	
07/05/01,1	Off	On	101	95	
07/06/01,2	Off	On	91	98	
07/07/01,3	Off	On	92	96	
07/07/01,4	Off	On	83	97	
07/08/01,5	Off	On	85	85	
07/09/01,6	Off	On	91	79	
07/10/01,7	Off	On	92	79	
07/11/01,8	On	Off	57	122	
07/12/01,9	On	Off	49	143	
07/13/01,10	On	Off	49	138	
07/14/01,11	On	Off	47	130	
07/15/01,12	On	Off	55	131	
07/16/01,13	On	Off	69	123	
07/17/01,14	On	Off	70	119	

Third test					
07/18/01	Start	Start	100	100	Expt. Start
07/19/01,0	Off	Off	71	40	
07/20/01,1	On	Off	37	66	
07/21/01,2	On	Off	-	-	Did not check; out of town
07/22/01,3	On	Off	40	68	
07/23/01,4	On	Off	41	89	
07/24/01,5	On	Off	49	93	
07/25/01,6	On	Off	54	95	
07/26/01,7	On	Off	52	91	
07/27/01,8	Off	On	60	70	
07/28/01,9	Off	On	78	89	
07/29/01,10	Off	On	83	83	
07/30/01,11	Off	On	82	89	
07/3101,12	Off	On	76	65	
08/01/01,13	Off	On	86	57	
08/02/01,14	Off	On	79	65	

Table 2. Number of German cockroaches in each enclosure in test with Transonic 800. Each test is a replication.

Date, and day	Unit in Enclosure		No. insects in A	No. insects in B	Remarks
	A	B			
First test					
06/18/01	Start	Start	100	100	Expt. Start
06/19/01,0	Off	Off	80	98	
06/20/01,1	Off	On	103	55	
06/21/01,2	Off	On	74	63	
06/22/01,3	Off	On	92	51	
06/23/01,4	Off	On	95	35	
06/24/01,5	Off	On	77	45	
06/25/01,6	Off	On	88	45	
06/26/01,7	Off	On	85	50	
06/27/01,8	On	Off	58	65	
06/28/01,9	On	Off	58	64	
06/29/01,10	On	Off	61	59	
06/30/01,11	On	Off	55	67	
07/01/01,12	On	Off	43	75	
07/02/01,13	On	Off	44	71	
07/03/01,14	On	Off	46	90	
Second test					
07/03/01	Start	Start	100	100	Expt. Start
07/04/01,0	Off	Off	89	35	
07/05/01,1	On	Off	61	41	
07/06/01,2	On	Off	59	43	
07/07/01,3	On	Off	62	42	
07/07/01,4	On	Off	59	54	
07/08/01,5	On	Off	70	56	
07/09/01,6	On	Off	75	51	
07/10/01,7	On	Off	78	47	
07/11/01,8	Off	On	95	39	
07/12/01,9	Off	On	102	27	
07/13/01,10	Off	On	115	25	
07/14/01,11	Off	On	127	20	
07/15/01,12	Off	On	135	17	
07/16/01,13	Off	On	137	18	
07/17/01,14	Off	On	138	24	

Third test					
07/18/01	Start	Start	100	100	Expt. Start
07/19/01,0	Off	Off	56	59	
07/20/01,1	Off	On	58	42	
07/21/01,2	Off	On	-	-	Did not check, out of the Town
07/22/01,3	Off	On	57	59	
07/23/01,4	Off	On	61	62	
07/24/01,5	Off	On	75	58	
07/25/01,6	Off	On	96	67	
07/26/01,7	Off	On	93	47	
07/27/01,8	On	Off	67	92	
07/28/01,9	On	Off	82	72	
07/29/01,10	On	Off	98	58	
07/30/01,11	On	Off	116	55	
07/3101,12	On	Off	125	35	
08/01/01,13	On	Off	119	45	
08/02/01,14	On	Off	85	35	

Table 3. . Number of German cockroaches in each enclosure in tests with Transonic Cix 0600 "A and Loud", Sunbeam and Lentek devices.

Date, and day	Unit in Enclosure		No. insects in A	No. insects in B	Remarks
	A	B			
Cix 0600, "A and loud", replicate 1					
08/8/01	Start	Start	100	100	Expt. Start
08/9/01	Off	Off	50	85	
08/10/01,0	Off	On	84	47	
08/11/01,1	Off	On	90	54	
08/12/01,2	On	Off	70	72	
08/13/01,3	On	Off	73	70	
Cix 0600, "A and loud", replicate 2					
08/13/01	Start	Start	100	100	Expt. Start
08/14/01	Off	Off	56	65	
08/15/01,0	On	Off	40	77	
08/16/01,1	On	Off	46	90	
08/17/01,2	Off	On	70	62	
08/18/01,3	Off	On	75	51	
Sunbeam unit*					
08/8/01	Start	Start	100	100	Expt. Start
08/9/01	Off	Off	93	96	
08/10/01,0	On	Off	97	68	
08/11/01,1	On	Off	98	77	
08/12/01,2	Off	On	107	62	
08/13/01,3	Off	On	109	68	
Lentek unit*					
08/13/01	Start	Start	100	100	Expt. Start
08/14/01	Off	Off	105	33	
08/15/01,0	On	Off	108	42	
08/16/01,1	On	Off	116	34	
08/17/01,2	Off	On	115	32	
08/18/01,3	Off	On	108	28	

* We did not replicate tests with Sundeam and Lentek, because these two devices failed to repel the cockroaches. Sounds produced by these units were reported earlier.

Table 4. Change in German cockroach numbers when exposed to ultrasound emitted from Cix 0600*.

Day	Off				On			
	Test				Test			
	1	2	3	Mean ± SE	1	2	3	Mean ± SE
				First 7-d test				
1	32	14	26	**24.0 ± 5.3**	-30	-17	-34	**-27.0 ± 10.1**
2	3	4	-	**3.5 ± 0.5**	-20	-14	-	**-17.0 ± 11.8**
3	-13	5	28	**6.7 ± 11.9**	-3	-16	-31	**-16.7 ± 8.9**
4	-17	-4	49	**9.3 ± 20.1**	4	-15	-30	**-13.7 ± 8.0**
5	-19	-2	53	**10.7 ± 21.7**	14	-27	-22	**-11.7 ± 9.9**
6	-18	4	55	**13.7 ± 21.7**	9	-33	-17	**-13.7 ± 7.3**
7	-15	5	51	**13.7 ± 19.5**	-1	-33	-16	**-16.7 ± 6.3**
Mean ± SE	**-6.7 ± 7.0**	**3.7 ± 2.2**	**43.7 ± 35.3**	**13.6**	**-3.9 ± 6.0**	**-22.1 ± 3.2**	**-25.0 ± 3.1**	**-17.0**
				Second 7-d test				
8	23	43	8	**24.7 ± 5.1**	-12	-35	-21	**-22.7 ± 6.7**
9	32	64	26	**40.7 ± 3.0**	-15	-43	-2	**-20.0 ± 12.1**
10	34	59	31	**41.3 ± 8.1**	-21	-43	-8	**-24.0 ± 10.2**
11	25	51	30	**35.3 ± 9.8**	-24	-45	-2	**-23.7 ± 12.1**
12	21	52	24	**32.3 ± 12.9**	-17	-37	-26	**-26.7 ± 5.8**
13	19	44	34	**32.3 ± 12.3**	-15	-23	-34	**-24.0 ± 5.5**
14	18	40	27	**28.3 ± 9.2**	-21	-22	-26	**-23.0 ± 1.5**
Mean ± SE	**24.6 ± 2.4**	**50.4 ± 3.3**	**25.7 ± 3.2**	**33.6**	**-17.9 ± 1.6**	**-35.4 ± 3.6**	**-17.0 ± 4.8**	**-23.4**

*Changes in cockroach numbers in enclosures were calculated based on the number of insects found on days 1-7 minus the number of insects found on day 0 for the first 7-d test period. Similarly, the number of cockroaches found on days 8-14 was subtracted from the numbers found on day 7 for the second 7-d test period.

Table 5. Change in German cockroach numbers when exposed to ultrasound emitted from Transonic 800*

Day	Off				On			
	Test				Test			
	1	2	3	Mean ± SE	1	2	3	Mean ± SE
First 7-d test								
1	23	6	2	**10.3 ± 6.4**	-43	-28	-17	**-29.3 ± 7.5**
2	-14	8	-	**-3.0 ± 11.0**	-25	-30	-	**-27.5 ± 2.5**
3	12	7	1	**6.7 ± 3.2**	-47	-27	0	**-24.7 ± 13.6**
4	15	19	5	**13.0 ± 4.2**	-63	-30	-13	**-35.3 ± 14.7**
5	-3	21	19	**12.3 ± 7.7**	-53	-19	-1	**-24.3 ± 15.2**
6	8	16	40	**21.3 ± 9.6**	-53	-14	8	**-19.7 ± 17.8**
7	5	12	37	**18.0 ± 9.7**	-48	-11	-12	**-23.7 ± 12.2**
Mean ± SE	**6.6 ± 4.6**	**12.7 ± 2.3**	**17.3 ± 7.2**	**12.2**	**-47.4 ± 4.4**	**-22.7 ± 3.0**	**-5.8 ± 3.9**	**-26.4**
Second 7-d test								
8	15	17	45	**25.7 ± 9.7**	-27	-8	-26	**-20.3 ± 6.2**
9	14	24	25	**21.0 ± 3.5**	-27	-20	-11	**-19.3 ± 4.6**
10	9	37	11	**19.0 ± 9.0**	-24	-22	5	**-13.7 ± 9.4**
11	17	49	8	**24.7 ± 12.4**	-30	-27	13	**-14.7 ± 13.9**
12	25	57	-12	**23.3 ± 19.9**	-42	-30	29	**-14.3 ± 21.9**
13	21	59	-2	**26.0 ± 17.8**	-41	-29	23	**-15.7 ± 19.6**
14	40	60	-12	**29.3 ± 21.5**	-39	-23	-11	**-24.3 ± 8.1**
Mean ± SE	**20.1 ± 3.8**	**43.3 ± 6.6**	**9.0 ± 7.8**	**24.1**	**-32.9 ± 2.9**	**-22.7 ± 2.8**	**3.1 ± 7.6**	**-17.5**

*Changes in cockroach numbers in enclosures were calculated based on the number of insects found on days 1-7 minus the number of insects found on day 0 for the first 7-d test period. Similarly, the number of cockroaches found on days 8-14 was subtracted from the numbers found on day 7 for the second 7-d test period.

Table 6. Change in German cockroach numbers when exposed to ultrasound emitted from Cix 0600 (A and loud) and two other devices (Lentek and Sunbeam)*

Test	First 2-day period				Second 2-day period			
	Day 1		Day 2		Day 1		Day 2	
	Off	On	Off	On	Off	On	Off	On
Transonic Cix 0600 (Mode A and Quiet)								
1	34	-38	40	-29	18	-20	16	-17
2	12	-16	35	-10	24	-28	29	-39
Mean ± SE	**23 ± 11.0**	**-27 ± 11.0**	**37.5 ± 2.5**	**-19.5 ± 9.5**	**21 ± 3.0**	**-24 ± 4.0**	**22.5 ± 6.5**	**-28 ± 11.0**
Sunbeam								
1	-28	4	-19	5	9	-15	11	9
Lentek								
3	9	1	3	11	-1	-2	-8	-6

* Changes in cockroach numbers in an enclosure were calculated based on the number of insects found on days 1-2 minus the number of insects found on day 0 for the first 2-d test period. Similarly, the number of cockroaches found on days 3-4 was subtracted from the numbers found on day 2 for the second 2-d test period.

Table 7. Analysis of variance results for responses of *B. germanica* exposed to three commercial ultrasonic devices (*Significant: $P < 0.05$).

Source	Numerator df, denominator df	*F*-value	*P*-value
	Device Cix 0600 at "A & Quiet"		
Treatment	1, 8.99	18.17	0.0021*
Period	1, 9	0.44	0.5247
Day (period)	12, 58	0.32	0.9824
	Device Cix 0600 "A & Loud"		
Treatment	1, 5	53.91	0.0007*
Period	1, 5	0.67	0.4517
Day (period)	2, 6	4.19	0.0725
	Device Transonic 800		
Treatment	1, 7.01	23.83	0.0018*
Period	1, 7.04	1.55	0.2526
Day (period)	12, 58.1	0.31	0.9840

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Greenhouse Spiders

Response of a greenhouse spider complex to ultrasound emitted from Transonic 800

Applica™

Applica Consumer Products, Inc.

Response of a greenhouse spider complex to ultrasound emitted from Transonic 800

Final Report

Submitted by

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June 1, 2002

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Objective: To determine responses of a greenhouse spider complex exposed to ultrasonic pulses from Weitech's Transonic 800 unit in natural room conditions.

Treatments: Transonic 800 unit and control (without ultrasound).

Sound measurements. Sound measurements were made on 14 units. For each unit, sound measurements recorded included peak frequencies, sound cycles, and SPLs. Measurements were made using a Bruel and Kjaer (B&K) type 4939 condenser microphone, B&K type 2670 preamplifier, and B&K NEXUS conditioning amplifier. Data were collected using a Tektronix 544A digitizing oscilloscope. Measurements were calibrated using a B&K type 4231 sound level calibrator. Measurements were made at a distance of 50 cm from the unit's transducer.

Assay procedure: A one-way paired design was used for the experiment. Three greenhouse rooms (one 500- ft^2 and two 625-ft^2 rooms) at Kansas State University, Manhattan, Kansas, were used for the experiment. Each room served as an experiment unit. In each room, two Pherocon 1C sticky traps (Trece Inc. Salinas, California) were put on the two ends of the floor as a paired test. An ultrasonic unit was set 1 ft away from one sticky trap and faced at the trap (Figure 1). Another sticky trap was used as a control in the paired test. The ultrasonic units were turned on all the time during the tests. The three rooms served as three replications. The number of spiders on traps was checked two times with a 2-week interval between observations (Figure 2). The sticky traps were replaced in each observation.

Data analysis: SAS Proc means was used to analyze the paired data to compare the difference in the total number of spiders captured between the paired traps (with/without ultrasonic unit).

Sound output: The ultrasonic device generated a wide range of peak frequencies between 27.7 and 42 kHz (Figure 3A) and produced an 88 ± 2 dB SPL. The waveform plot (Figure 3B) had a single sound cycle that was 0.075 seconds in duration. The device generated three groups of pulses and each group was characterized by multiple pulses.

Results and Discussion: Several spider species were trapped during the experiment. Most of spiders captured were long-bodied cellar spiders, *Pholcus phalangioides* (Fuesslin) (Order: Araneae; Family: Phalangiidae). With inactive ultrasonic units, an average of 4.00 ± 0.58 (mean $\pm$ SE) spiders were captured per sticky trap (Table 1). In contrast, with active units, only 1 ± 0.58 spiders were captured per trap. The difference is statistically significant at the 5% level (Df=2; t=5.1962; p=0.0351).

In conclusion, the Transonic 800 unit was able to repel the spiders under the test conditions.

Table 1. Total number of spiders captured in each spot and the T-test results

Treatments	# of spiders ± MSE	difference	T-value	P-value
Control	4.00 ± 0.58			
T 800	1.00 ± 0.58	3.00 ± 0.58	5.1962	0.0351

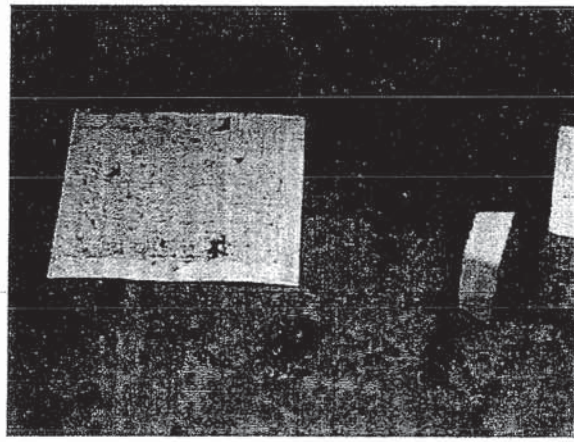


Figure 1. An ultrasonic unit was set 1 ft away from one stick trap and faced at the trap

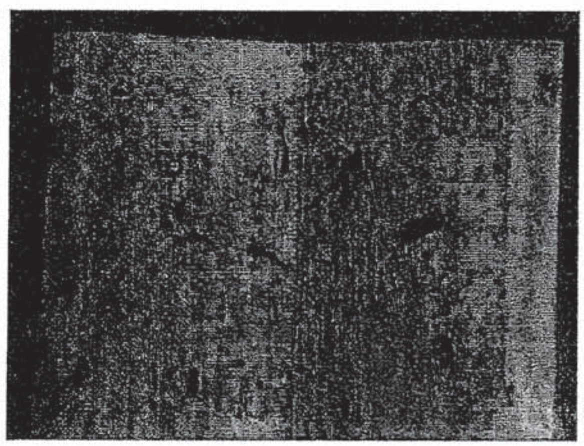
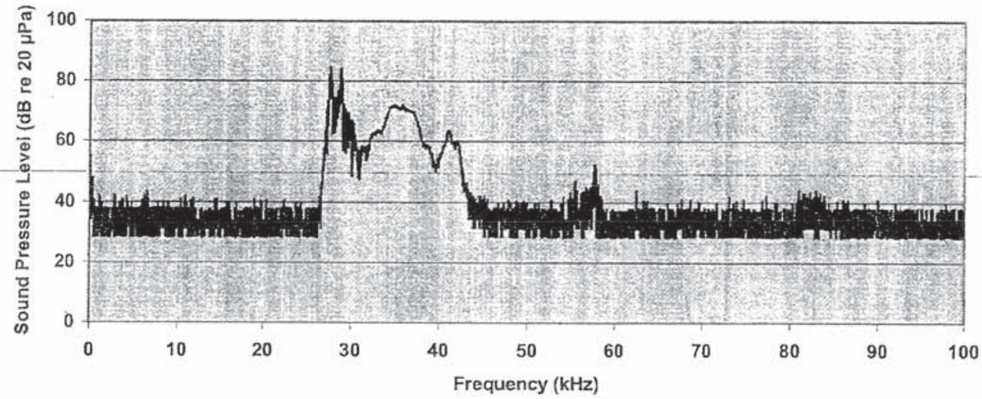


Figure 2. Number of spiders was checked two times with a 2-week interval

A



B

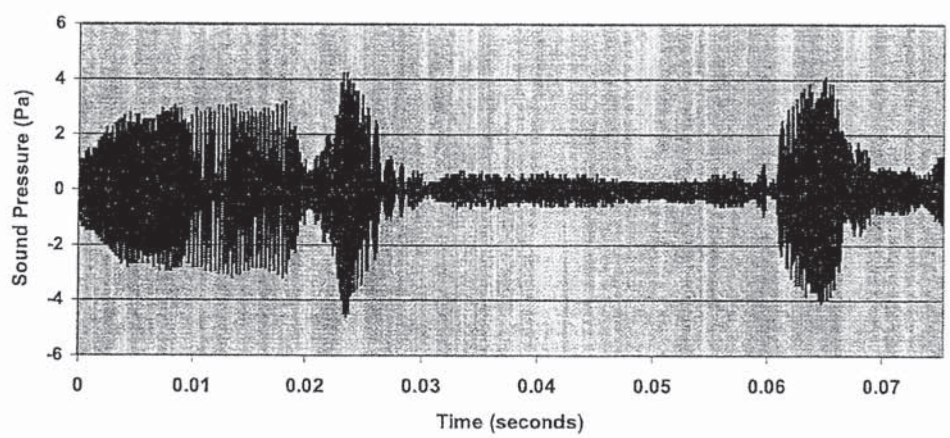


Figure 3. Ultrasound output signal from Transonic 800 units at 50 cm A: Frequency Spectrum; B: Waveform graph.

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Long-bodied Cellar Spiders

Response of long-bodied cellar spiders, to ultrasound emitted from Transonic 100

Applica™
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Response of long-bodied cellar spiders, *Pholcus phalangioides* (Fuesslin), to ultrasound emitted from Transonic 100

Final Report

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June 1, 2002

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Objective: To determine responses of long-bodied cellar spiders, *Pholcus phalangioides* (Fuesslin) (Order: Araneae; Family: Phalangiidae) exposed to ultrasonic pulses from Weitech's Transonic 100 in natural room conditions.

Treatments: Transonic 100 and control (without ultrasound).

Sound measurements. Sound measurements were made on 11 units. For each unit, sound measurements recorded included peak frequencies, sound cycles, and SPLs. Measurements were made using a Bruel and Kjaer (B&K) type 4939 condenser microphone, B&K type 2670 preamplifier, and B&K NEXUS conditioning amplifier. Data were collected using a Tektronix 544A digitizing oscilloscope. Measurements were calibrated using a B&K type 4231 sound level calibrator. Measurements were made at a distance of 50 cm from the unit's transducer.

Assay procedure: A completely randomized design was used for the experiment. Ten rooms (most are storage rooms) around the Kansas State University campus were selected for the experiment. Each room was served as an experiment unit. In each room, a Pherocon 1C sticky trap (Trece Inc. Salinas, California) containing 4 Indianmeal moth adults was put on the floor (Figure 1). For the treated rooms, an ultrasonic unit was set 1 to 5 ft away from the trap and faced to the trap. The ultrasonic units were turned on all the time during the experiment. For the untreated rooms (control), there were no ultrasonic units. The five rooms for each treatment served as five replications. The number of spiders was checked five times at various time intervals (4- 8 days).

Data analysis: SAS Proc glm was used to analyze the data to compare the difference in the number of spiders captured between the treated and untreated rooms (with/without ultrasonic unit).

Sound output: The ultrasonic device generated peak frequencies at 27 kHz and 35 kHz (Figure 2A) and produced a 92 ± 4 dB SPL. The waveform plot (Figure 2A) showed that the ultrasonic device had 0.123 seconds of one cycle of the sound produced. The device generated two groups of pulses, with 8 pulses in each group. The first group of weaker pulses was followed by a second group of stronger pulses.

Results and Discussion: All except 2 spiders captured were long-bodied cellar spiders, *Pholcus phalangioides* (Fuesslin) (Order: Araneae; Family: Phalangiidae). The data in Table 1 are based only on the capture of long-bodied cellar spiders. The number of spiders captured was reduced under exposure to the ultrasound emitting from the ultrasonic units by an averaged rate of 67%. In the rooms without ultrasound, 4.2 ± 0.49 (mean $\pm$ SE) spiders were captured per sticky trap compared to 1.4 ± 0.40 spiders captured under the exposure to ultrasound. The difference is significant at the 1% significant level (Df=1, 8; F=19.6; p=0.0022).

In conclusion, the ultrasonic device, Transonic 100, has the ability to repel the spiders and its repelling efficacy reached the 1% significant level under the test conditions.

Table 1. Number of long-bodied cellar spiders captured per traps

Treatments	# of spiders ± MSE=
Control	4.2 ± 0.49
Transonic 100	1.4 ± 0.40

=

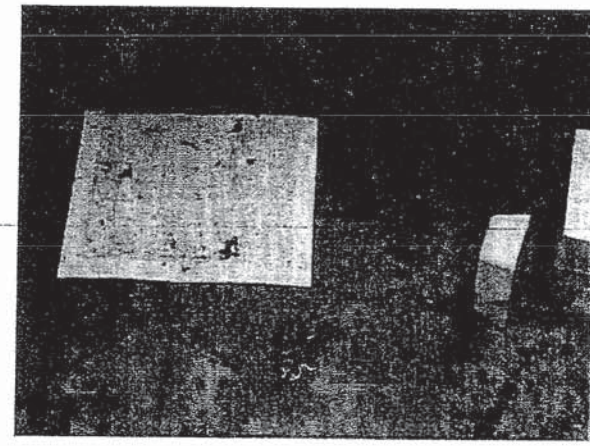
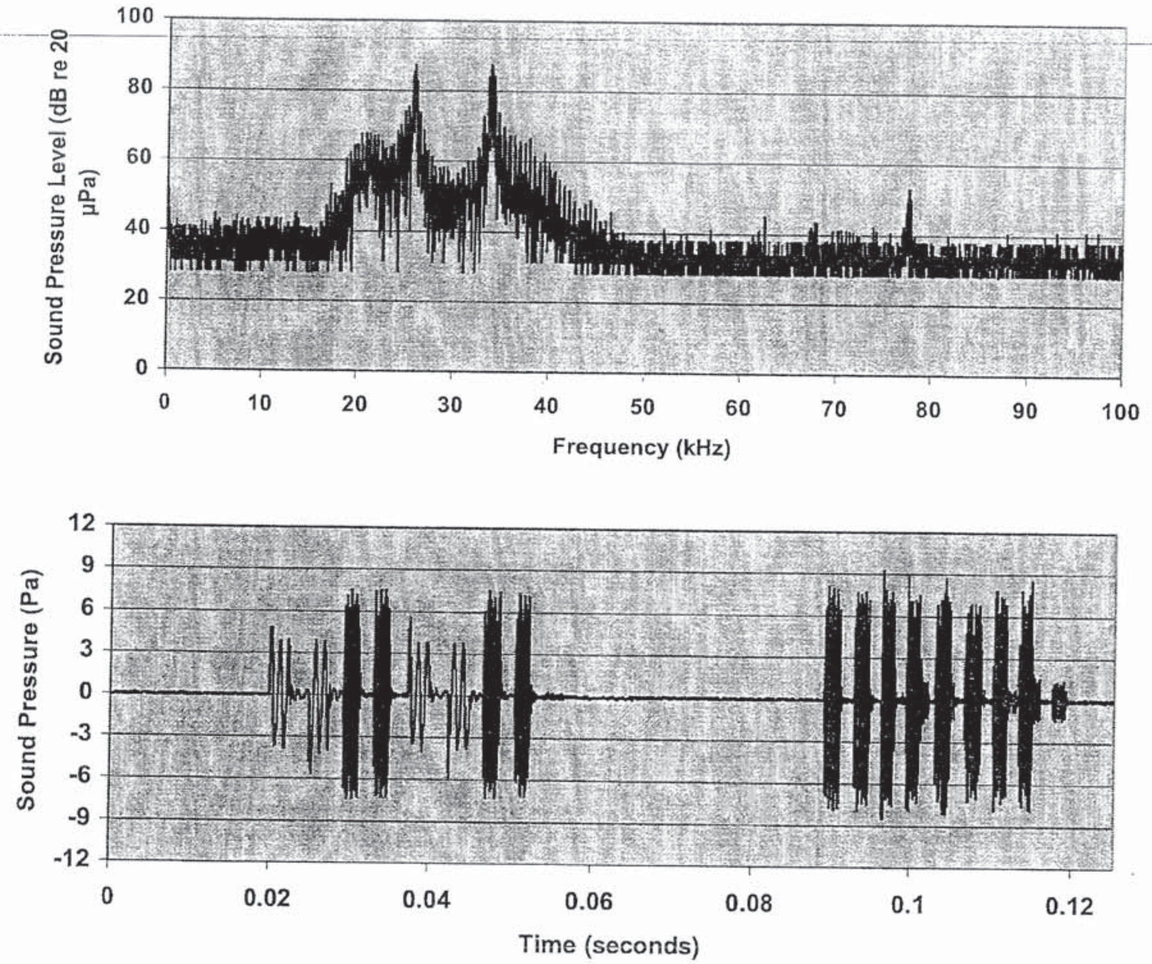


Figure 1. A Pherocon 1C sticky trap containing 4 Indianmeal moth adults was put on the floor.

A



B

Figure 2 Ultrasound output signal from Transonic 100 at 50 cm A: Frequency Spectrum; B: Waveform graph.